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coal development in eastern montana

A Situation Report
of the
Montana Coal Task Force
January, 1973

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ERRATA SHEET

Page 33. The misspelled word flesibility in the second to the last sentence in the last paragraph should correctly be spelled flexibility.

Page 39. The word information in the second sentence of the third paragraph should be replaced with the word formation.

Page 62. The first sentence of the last paragraph should read:

> If indeed 800,000 acres, or 1,250 square miles, are disturbed either temporarily (as present state regulations require) or permanently (as some people fear), this amounts to about three (3) percent of the total land in the 14 counties.

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

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January 12, 1973

The Honorable Thomas L. Judge
Governor of the State of Montana
State Capitol Building
Helena, Montana 59601

Dear Governor Judge:

On August 2, 1972, a state agency coal task force was established by directive of Governor Forrest H. Anderson. In accordance with that directive, the "Coal Situation Report" of the Coal Task Force is respectfully submitted for your review and distribution.

I believe this report will prove to be of considerable value as a broad review of anticipated and ongoing coal development in the State and as an indication of the problems such development poses for Montanans.

Sincerely,

Gary J. Wicks

GARY J. WICKS, DIRECTOR
DEPARTMENT OF NATURAL
RESOURCES & CONSERVATION

GJW/tkr

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ACKNOWLEDGEMENTS

The Montana Coal Task Force and staff wish to thank those who helped in the preparation of this report: Harold M. Price and Jim E. Richard, Department of Intergovernmental Relations; and Carole I. Massman and James H. Nybo, Department of Natural Resources and Conservation.

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Elmore C. Grim, U.S. Environmental
Protection Agency

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PREFACE

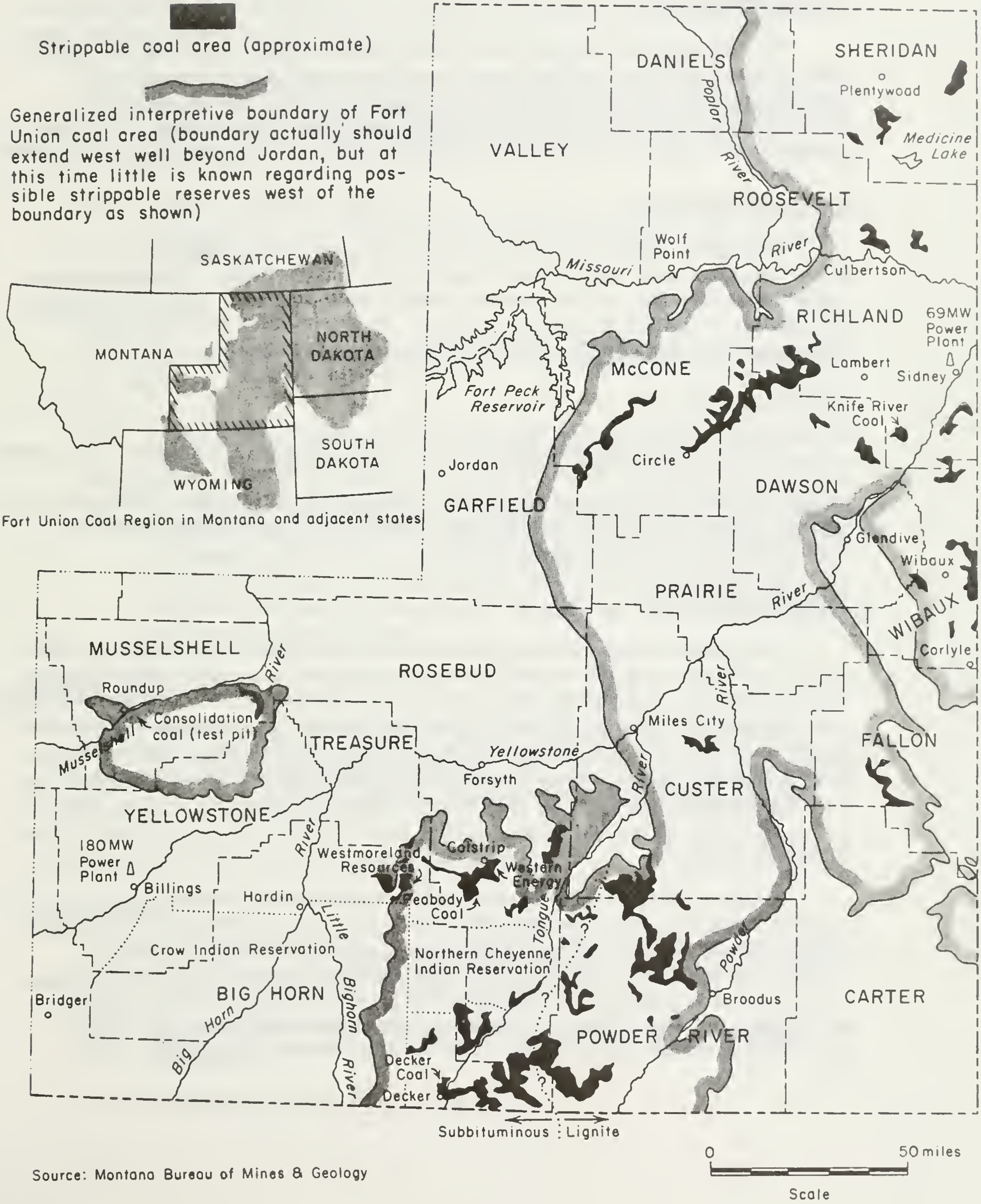
In August, 1972, when Governor Forrest H. Anderson appointed the State Coal Task Force, he expressed concern about ". . .the broad environmental, social, and economic impacts that coal development portends for the eastern part of our State." The task force was requested to "identify problems and research needs," "review existing laws and recommend the changes necessary for orderly development." To meet these directives, the task force has prepared a non-technical report, together with recommendations.

Although covering a wide range of subjects, the report is acknowledged to be incomplete in many respects. Evidence is fragmentary and inconclusive, and the fact remains that we know very little. In trying to determine the interrelationships, assess the trade-offs, and agree upon an acceptable balance between coal development and environmental integrity, we have continually encountered unknowns or unmeasurables. Also disconcerting are certain contradictory findings.

Even though we lack adequate understanding and agreement on the specifics and magnitudes of our present and potential resource and human problems, we have no disagreement about their urgency and the need for further understanding of the immediate and long-range consequences of any level of coal development or non-development.

The task force welcomes comment on this report, for we intended it to be evocative. We urge that discussion and debate continue, giving rise to policy formulation and deliberate action.

FORT UNION COAL AREA IN EASTERN MONTANA



Source: Montana Bureau of Mines & Geology

RECOMMENDATIONS

Recommendation #1

The state should be given power to regulate or deny the siting and certain design features of energy conversion plants and dams, and the routing of railroads, pipelines, transmission lines, aqueducts and associated facilities, to minimize the adverse impacts while obtaining an equitable balance of tradeoffs. Montana presently has no control of siting, design and/or routing of such facilities.

Recommendation #2

Montana's laws extend to private interests, by right of eminent domain, the privilege of acquiring surface rights for certain purposes, including mining, under conditions that may be contrary to the public interest. This is a source of apparent inequities and social problems. Revision of the law should be considered, but the complex issues deserve careful study.

Recommendation #3

Social, environmental, and economic costs will result from coal development. It is recommended that these "hidden" costs be borne to the fullest possible extent by energy conversion companies ultimately to be reflected in the consumer's cost of energy. Legislative reforms can improve tax and regulatory statutes and clarify standing for civil actions.

Recommendation #4

The potential impacts associated with coal development in eastern Montana are of such magnitude and diversity that the state and local governments cannot fully cope with pending problems. Because the situation arises from the increasing energy demands of the entire nation, and because energy conversion companies presently do not bear the entire costs of development, the federal government should assume a larger responsibility through funding needed research and providing impact funds for the local communities affected.

Recommendation #5

Montana's water rights system neither assures the owner of a water right true claim to water nor gives the public any voice in the overall allocation of this limited resource. Water rights reform should be enacted to protect the validity of existing water rights, to give the state control over new uses of water, and to guarantee a complete and current inventory of water rights and water use. In addition, the Montana Water Resources Act of 1967 should be strengthened, giving specific authority to implement the purposes of the Act.

Recommendation #6

Many areas of information shortages have been identified. Because the quality of a resource decision is related to the quality of the information base, we recommend the following:

a. that the state reduce this "information gap" by the application of the proficiencies of state and federal governments and the university system, through expanded research, increased funding, and improved agency coordination.

b. that whenever possible, irreversible resource decisions of significant magnitude should be postponed until the information gap can be narrowed.

Recommendation #7

The state should identify societal goals and institutionalize the mechanisms for achieving these goals by establishing:

a. specific long-range natural and human resource planning objectives, including land use, growth, population, transportation, and energy;

b. a planning process that will inventory natural and cultural resources, identify geographic areas or development impacts that are of regional or statewide concern, and ensure implementation of necessary planning and land use regulations. Any county without a planning board to address its important planning problems should be required to create one within a year.

Recommendation #8

Since the use of coal or any other mineral resource involves economic as well as environmental and social impacts, it is in the state's interest to minimize the adverse effects. Further, the state should favor those forms and levels of development that optimize long-term returns to the affected localities, as well as the state, in the form of stable employment levels and net tax yields, which help in fulfilling community and social needs.

Recommendation #9

It is recommended that deficiencies in existing state strip mine reclamation statutes be corrected by new legislation providing for:

a. state control of mining methods as necessary to assure adequate reclamation;

b. selective prohibition of strip mining;

c. mandatory topsoil salvage and recontouring;

d. increased bonding levels;

e. authority to promptly close a mine in serious violation of the law;

f. citizens' standing to sue when the law is allegedly being improperly administered;

g. prevention of waste of coal.

INTRODUCTION

A Problem of National Scope

The coal development issue is not an isolated environmental problem, for it is a component of many broad energy and policy issues of national scope. The production and use of energy is probably the greatest single environmental question posed to our society today. The First Annual Report of the President's Council on Environmental Quality, dated August 1970, states:

> The conflicts between consumption patterns that we all want and the environmental ill effects that we wish to avoid are sharper for energy than for perhaps any other aspect of resource use.

A report of the Committee on Interior and Insular Affairs, United States Senate, entitled "Problems of Electrical Power Production in the Southwest," gives insight into issues that should concern Montana. A cover letter to the Report by Senator Henry M. Jackson, Chairman of the Committee, illustrates the situation, and portions of that letter are presented herein.

> As the analysis in the report displays, the major part, at least, of the energy planned to be produced by these plants (Four-Corners Region) is urgently needed.
>
> Furthermore, development of these plants would bring employment and economic activity to the desert region. . .
>
> At the same time, it appears equally certain that development of the energy resources of the Four-Corners Region, regardless of the very best measures which technology can provide, will have significant adverse environmental impacts.

Senator Jackson further identifies the difficulty of reconciling the conflicts, even when the desire to do so exists, and the difficulty of determining the consequences of energy development, as follows:

> As in all such complex environmental conflicts, the solutions are not obvious; the trade-off decisions are difficult. Certainly all technologically achievable methods should be used to minimize or prevent adverse environmental impacts. Beyond the agreement on that point, however, there is little agreement on what public objectives should be paramount, what role intangible or unquantifiable values should play, or even what are the facts concerning the physical consequences of development.

The Situation in Montana

Potential utilization of Montana's coal, an immediate but possibly short-term energy resource, is probably the most critical social, environmental, legal and institutional problem facing Montana. A dilemma confronts the State of Montana and the entire Fort Union Region of the Northern Great Plains, because this area contains both coal and the water needed for the conversion of coal to usable energy for the nation. These two resources, together with the low population of the area, indicate that eastern Montana and the Fort Union Region as a whole will probably have a disproportionate share of energy producing facilities. While energy will be transported out of the state, major impacts will remain in Montana -- costs borne by the citizens of Montana, not the ultimate users of energy.

Because of the pressures to develop Montana's coal resource, three general problem areas have been identified which require extensive deliberation before final and often irreversible decisions are made. These are (1) the tempo of coal exploitation, (2) the maintenance and enhancement of environmental quality, and (3) the development of human goals and images of future society.

A question exists as to how the state can control the pace of coal extraction to insure the conservation and optimum use of a valuable and irreplaceable resource. It is, however, essential for the State of Montana to formulate policy which determines usage rate in order to assure that the conservation of this resource be maintained for the benefit of all society. Presently, decisions affecting the methods and rate of coal usage are made mainly in the private sector where resource uses are appraised from a short-run, current and potential market demand situation.

The location of energy conversion facilities in rural Montana will result in the residents of the area bearing most of the adverse environmental impacts, although they neither create the demand for the energy nor benefit proportionately from its generation.

Pollution-environmental problems can be summed up in the proposition that benefits are generally produced jointly with detriments. To fully consider all trade-offs between "goods and bads" when decisions are made is difficult because of general scientific uncertainty, a (human) tendency to suppress negative information, and the consistent failure of our mixed market price system to properly assess and assign the costs of the "bads." Therefore, there may exist a tendency to overestimate the "goods", and according to Economist Kenneth Boulding, ". . . indulge in processes of production that produce too many bads per good."

Eastern Montana is sparsely populated with an economy based upon agriculture. If this agricultural society is transformed into an industrial society with associated rapid population increases, many social and physical changes will result. A difficult question that needs resolution is a determination of the type of future society and optimum population that are desirable for the area, with consideration given to human needs and their interrelationship with natural systems. When ultimate goals are defined, then means should be implemented to insure that we are moving toward those goals.

The Need for Public Policy

In the past, society resolved (usually by default) conflicts between growth and environmental quality in favor of growth, because environmental and human considerations were of less importance. However, we have progressed to a level where harmony between man and his environment is a stated public objective both at the state and national levels. Therefore, drawing government into this realm of policy-making is necessary if human goals are to be defined and achieved with conflicts and uncertainty minimized. Without public policy the ultimate choices go by default.

OVERVIEW *

Reasons for Renewed Interest

Montana's coal reserves are again becoming economically important after 15 years of relative inactivity. The primary reasons for the recent renewed interest are the vast quantities available as well as the chemical properties of the coal. It is low in sulfur, sodium, and ash and is nonagglomerating and chemically reactive. Also of significance is the intimate relationship between coal and water supplies, the low cost of shipping through unit trains, increased demand for electricity, and recent advances in coal hydrogenation (8).

In the eastern portion of Montana underlain by coal, a combination of angular sandstone-capped buttes, deeply dissected badlands, rolling hills, and dry climate has resulted in a population density of about one person per square mile and an economy based primarily on livestock. The area contains little industry, few towns of more than 2,500 people, and a limited amount of dry and irrigated farming where the terrain permits, but a great majority of the land is devoted to livestock grazing.

Geology and Reserves

The coal basin, which consists of parts of four states and Saskatchewan is known as the Fort Union area, named after the formation in which the coal is found. It is Paleocene in age and consists of sandstones, siltstones, claystones, and numerous coal beds in an interlayered sequence. The coal-bearing portion of the Fort Union Formation is primarily of fluvial origin, containing sediments derived from the Rocky Mountains to the west. The terrain on which these sediments were deposited was a low floodplain that contained large subsiding swampy areas and was crossed by numerous meandering streams.

The Fort Union Area is perhaps the largest coal basin in the world, containing 40 percent of the United States reserves. Total reserves have been estimated to be 1.3 trillion tons (15), with strippable reserves in Montana calculated to be more than 30 billion tons (9).

Strippable coal is defined as a seam having a minimum thickness of six feet and overlain by 150 feet or less of overburden. It must be relatively free of shale partings and of sufficient areal extent to allow economic production (3).

---

* Thomas J. Gill, "Coal Development Potential in Eastern Montana," Montana Environmental Quality Council, First Annual Report, October 1972, pp. 141-146.

Water Availability

Water controls all activity in this semiarid region, and the industrial future of the Fort Union coal fields is no exception because coal-based development requires enormous quantities of water for cooling and conversion. Because most of the coal fields are far removed from existing surface water sources, the nature and extent of development would depend on the quantity of water made available at the mine site. A large volume of easily accessible water would allow extensive generating and conversion complexes. If this supply is not provided through several new storage facilities and an intricate system of government pipelines, development would be more restricted and probably concentrated on mining and export of coal.

The future use of ground water in coal fields development has not yet been firmly established. Evidently very little deep exploratory drilling for water has been done, although the Montana Power Company has drilled to a depth of about 9,300 feet into Mississippian sediments near Colstrip. The chemical suitability of the water varies, but the deliverability of the well looks favorable. It taps three aquifers and flows at a rate of 60 gallons per minute (12). However, the Montana Bureau of Mines indicates that ground water resources are not adequate to facilitate large-volume industrial development (8).

Surface water sources in the Montana Fort Union area are the Missouri, Yellowstone, Powder, Tongue, Bighorn, and Little Bighorn rivers. Industrial utilization requires flow control on the streams from which installations draw their supply. This control is obtained through the use of dams and offstream storage reservoirs. Storage facilities in the general area include Bighorn Lake, Tongue River Reservoir, Fort Peck Reservoir, and the proposed Moorhead Reservoir on the Powder River. The Bureau of Reclamation is also considering Allenspur Dam on the Yellowstone River and two offstream reservoirs on the north side of the river between Forsyth and Billings. A summary of available and potential industrial water from each source is as follows (23):

	Acre-Feet	
	Available	Potential
Bighorn River		
Bighorn Lake	262,000	
Powder River		
Moorhead Reservoir		57,000
Tongue River		
Tongue River Reservoir		60,000
Yellowstone River		
Mainstem (with regulation by offstream reservoirs or Allenspur)		1,356,000

	Acre-Feet	
	Available	Potential
Missouri River (21)		
Fort Peck Reservoir	1,000,000 (approximately)	

The Bureau of Reclamation has proposed an aqueduct system for the purpose of providing water for coal development. The agency investigated several routes and delivery points with the primary Montana termini in the areas of Colstrip, Sarpy Creek, Sweeney Creek, Crooked Creek, and Pumpkin Creek. In response to an inquiry, some of the potential users exhibited a definite interest and indicated that total aqueduct capacity should be about 2.6 million acre-feet per year (12). The earliest requested delivery date was 1977, with the majority of the firms listing 1980 as the target date for completion of the system (7).

A significant quantity of water is present on Indian lands in Montana. To how much of this the Indians would be entitled is still undetermined, although it is expected that they would be first in line. The Indians' share would provide a marketable product for the tribes involved, but the anticipated legal battle would have to be settled prior to construction of the aqueduct.

A shortage of water is developing in eastern Montana, especially in the Yellowstone River drainage. The Bureau of Reclamation (22) indicates that 871,000 to 1,004,000 acre-feet of water per year from Montana's portion of the Yellowstone, Bighorn, Powder, and Tongue Rivers are presently under option by energy companies. The agency has also received requests or indications of interest in another 945,000 acre-feet from these streams (23). The appraisal report on Montana-Wyoming aqueducts indicates that the state's total existing and potential supply of water from these sources amounts to 1,735,000 acre-feet per year. Fort Peck Reservoir on the Missouri River has about one million acre-feet of available water that will probably be used as a source for any installations north of the Yellowstone. Additional storage development on the Missouri, such as the proposed High Cow Creek Dam, could expand the supply of industrial water.

In general, it seems safe to assume that a supply of water sufficient to accommodate the coal developments currently under consideration would require complete development of the area's water resources. This would not only mean more dams, but interbasin and interstate transportation of water through the network of pipelines proposed by the Bureau of Reclamation. Before construction begins, the benefit derived from such action should be carefully weighed against other possible uses of the water as well as cumulative primary and secondary environmental impacts. In this area of vast strippable coal deposits, water is the key, whether for production of synthetic crude oil, synthetic pipeline gas, by-product chemicals, or electric power generation. Provision of a readily available water supply would have far-reaching effects -- environmentally, socially, and economically.

Recent Developments

Major firms interested in Montana coal are as follows: **

Firms	Location
Amax Coal Co.	Indianapolis, Indiana
Chevron Oil Co.	San Francisco, California
Colorado Interstate Gas Co.	Colorado Springs, Colorado
Consolidation Coal Co. (Continental Oil Co.)	Pittsburgh, Pennsylvania
Decker Coal Co. (Pacific Power & Light; Peter Kiewit Son's Inc., Omaha)	Portland, Oregon
Gulf Mineral Resources Co. (Gulf Oil Co.)	Denver, Colorado
Knife River Coal Co. (Montana-Dakota Utilities)	Bismarck, North Dakota
Norsworthy and Reger, Inc.	Billings, Montana
Northern Natural Gas Co.	Omaha, Nebraska
Peabody Coal Co. (Kennecott Copper Corp.)	St. Louis, Missouri
Shell Oil Co.	Denver, Colorado
Western Energy Co. (Montana Power Co.)	Butte, Montana
Westmoreland Coal Co.* (Westmoreland Resources)	Philadelphia, Pennsylvania

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** Montana Division of Planning and Economic Development

Areas affected by coal development are as follows: **

Cities and Towns

Ashland
Baker
Birney
Broadus
Crow Agency
Decker
Hardin
Hysham
Lame Deer
Lodge Grass
Miles City
Saint Xavier
Savage
Sidney

Counties

Big Horn*
Custer*
Dawson
Fallon*
Garfield
McCone
Musselshell*
Powder River*
Richland*
Roosevelt
Rosebud*
Sheridan
Treasure*
Wibaux

Coal companies now operating strip mines in Montana include the following:

Western Energy at Colstrip began production in 1968 at a rate of half a million tons per year and expanded to about five million tons in 1971 (15). The mine provides coal for the Corette steam generation plant in Billings as well as 2.3 million tons yearly to Wisconsin Power and Light.

Peabody Coal Company opened a test pit seven miles south of Colstrip in 1968. The company supplies Minnesota Power and Light with two million tons of Rosebud coal annually.

Decker Coal Company is expected to mine about 3.4 million tons in 1972 near the community of Decker in southeastern Big Horn County (15). A railroad spur linking Decker with northern Wyoming has recently been completed. Shipping costs are reduced through use of a unit train on which coal is the only commodity transported. The rate per ton varies with the quantity of coal to be delivered and the distance to destination.

Knife River Coal is operating in the eastern part of the state near Savage. The company produces about 320,000 tons of coal per year and disturbs 20 additional acres of land per year (13).

Consolidation Coal Company has a pit in the Bull Mountains from which it removed 39,000 tons for the test burn in 1971. Recent information also indicates that Consol has asked the Northern Cheyenne tribal council for leases on 90,000 acres of reservation land (18).

Westmoreland Resources recently announced plans to begin mining on upper Sarpy Creek in Bighorn County. The company has contracted to sell four midwestern utilities 76.5 million tons of coal over a 20 year period beginning in March, 1974 (26). The initial contracts are with Northern States Power

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* Development and/or leasing activity in progress.
** Montana Division of Planning and Economic Development

(Minnesota), Interstate Power Company (Iowa), Dairyland Power Cooperative (Wisconsin), and Wisconsin Power and Light. A 36 mile branch rail line up Sarpy Creek is now under construction.

The next mining operations are likely to be (15) Peabody Coal on the Northern Cheyenne Indian Reservation and Consolidation Coal in the Bull Mountains.

Montana's coal basin has undergone intense leasing activity. Many companies and private individuals have leased 57,534 acres of state land for the purpose of exploring and mining coal. The Montana office of the Bureau of Land Management has issued 37 leases embracing 52,588 acres in Montana and North Dakota. Seventeen of these leases are in Montana and encompass 37,152 acres of which approximately 95 percent is in private surface ownership. Production has begun on only 12 of the 37, amounting to approximately 1.5 million tons in 1971. In addition to these leases, there are 14 valid prospect permits embracing 37,544 acres in the two states.

The BLM also had under consideration 119 applications for prospect permits in Montana and North Dakota by 20 applicants, affecting 419,684 acres. The bureau denied these applications, stating, ". . .there is no compelling need, at this time, to encourage further prospecting for a resource when there is already a known supply under lease that is waiting to be developed" (28).

About 16,000 acres of Indian land have also been leased. Two costs are involved here, a lease fee and a development cost similar to the improvement requirement on a locatable mineral claim. After a certain number of years, following review by the U.S. Department of Interior and the Bureau of Indian Affairs, a lease can be canceled if mining operations have not begun. The grace period is usually about 10 years.

Coal-fired steam generation plants presently operating in the state are located in Billings and Sidney. Montana Power has begun construction of a 700-megawatt mine-mouth plant at Colstrip, the first 350-megawatt unit of which is scheduled to be completed in 1975 (2).

Water for the Colstrip plant(s) will be piped from the Yellowstone River to Colstrip through a 60 inch pipeline. Montana Power's notice of appropriation, dated December 16, 1970 claims an appropriation of 250 cubic feet per second (112,200 gallons per minute) on all days and at all seasons (16) of the year.

What Does the Future Hold if We Have. . .

Strip Mining and Export?

The Montana Bureau of Mines and Geology indicates that 1973 coal production in this state will be about 16 million tons and that it will be expanded to more than 20 million tons annually by 1975 (9,15). The increasing demand for low-sulfur coal could accelerate strip-mining activity and lead to significantly higher production figures in the near future.

MONTANA COAL PRODUCTION (9, 11, 15)

Year	Production
1969	1 million tons
1971	7 million tons
1973	16 million tons
1975	20 million tons
1980	75-80 million tons

With proliferation of strip mining comes the problem of large-scale reclamation. Extraction of 16 million tons of coal per year from the present mines will overturn 275 to 520 acres of land per year, while full employment of Montana's strippable reserves could disturb a maximum of about 770,000 acres (27). Although eastern Montana does not have problems with such things as acid drainage, reclamation efforts are complicated by the semiarid conditions of the region. The scarcity of water makes regrowth of any type of vegetation a very slow process. Previous experience shows that unconsolidated spoils left at the angle of repose will not support an effective vegetative cover and that simply leveling the tops of the spoils will do little to alleviate the problem; however, stockpiling soil, contouring spoils, and subsequent use of farm equipment for soil conditioning and seeding offer some possibilities.

In areas such as Decker, in which the coal bed is an aquifer, mining will have a definite impact on ground water supply, movement, and rate of recharge. A well near the test pit at Decker lost five feet of head after excavation, and evidence indicates that all water will eventually be drained from the coal bed aquifer. Wells may have to be deepened to tap other aquifers as mining progresses. Because spoils have lower permeability than the coal bed, cessation of mining and filling the final cut will restrict ground water movement and raise the water table up-gradient from the mine site. After reclamation, the mined area might serve as a zone of local recharge.

Assuming that reclamation is effective, there would still be a considerable delay before land could be returned to its original use. Until the vegetative cover is firmly established, grazing would be impossible. Wildlife would be displaced for an unknown period, with no assurance that the subsequent habitat created on the spoils would satisfy all the needs of native species.

Strip mining and export would cause other environmental problems. Among these are a dust problem, at least temporarily, in the mining area and vicinity and additional railroad corridors if the coal is shipped by unit train. If coal-slurry pipelines are used, large quantities of Montana water will be exported, causing possible local depletion.

Because of the high degree of mechanization in the mining and transportation processes, development for export would probably cause only a small increase in job opportunities and no significant change in the area's overall employment pattern.

Mine-mouth Generating Plants?

The requirements for a mine-mouth generating installation are: proximity to fuel source, market, or both; access to large supplies of cooling water; freedom from floods or other predictable natural disasters; and a large tract of land available at a moderate cost. Eastern Montana meets all the requirements except market, and the development of extra-high-voltage grids would provide that.

The North Central Power Study (17) estimates a steam-fired generating capacity of 53,000 megawatts in the Gillette-Colstrip oval by 1980. The complex would provide electricity within a 13-state area and for users as far away as St. Louis, Missouri. Something less than half of the capacity would probably be generated in Montana, which contains 21 of the 42 potential sites. The plants range in size from 1,000 to 10,000 megawatts (the Corette plant in Billings is 180 megawatts), with total estimated coal consumption in excess of 200 million tons per year. About 300-500 full-time employees would be required to operate the Montana plants. These would be in addition to personnel needed for maintenance and service of transmission lines and operation of the mines.

Full development of all 21 North Central Power Study sites in eastern Montana would result in an instate steam-generating capacity of about 69,000 megawatts. Most of the Montana plants would be in the 1,000 and 5,000-megawatt categories, while a large percentage of the Wyoming installations would have 10,000-megawatt outputs.

Recent Bonneville Power Administration information suggests that Montana coal will be used to generate electricity for the Pacific northwest (6). A memo to Forest Service files reporting on a May 11, 1972 meeting in Portland, Oregon indicates that thermal generation is best suited for base purposes and will thus be emphasized by BPA. Projected average demands in the BPA region will probably require an average thermal generating capacity of about 13,000 megawatts by 1982 and 23,000 megawatts by 1992 with even higher peak requirements (6). Although these plans are probably tentative and subject to change, Colstrip is suggested as the location for two additional 700 megawatt units scheduled for completion in September 1978 and September 1979. Five hundred and twenty-five megawatts from each unit will be transmitted to consumers in the Pacific northwest (6).

Mine-mouth generation in the Fort Union area will require new and larger transmission facilities (500-700kv lines) (6). The location of transmission corridors containing lines of this size is a subject of controversy throughout the state, particularly in the national forest land of western Montana and Idaho. BPA recognizes three suitable routes through western Montana but favors the Magruder Corridor which leads west from Anaconda and into Idaho between the Selway-Bitterroot Wilderness and the Salmon River Breaks Primitive Area. Other possible corridors are: (1) Anaconda-Hot Springs and westward along the route of the current Dworshak-Hot Springs line, and (2) a line through Anaconda-Hot Springs-Spokane-Grand Coulee and south to Hanford and Umatilla, Oregon.

One of the serious problems associated with the plants is that of airborne contaminants. Even with the most advanced pollution control equipment, enormous amounts of pollutants would be introduced into the atmosphere as a result of the vast quantity of coal used. Electrostatic precipitators and wet scrubbers can remove 99 plus percent by weight of the particulate matter but a much smaller percentage of fine material (less than one micron in diameter). Unfortunately, it is the fines that stay suspended longest, enter most easily and deeply into the lungs, and inhibit visibility. Suspended particles also reflect solar radiation and may seed storms and otherwise alter downwind weather patterns (20). A current example of the problem is the 2,075-megawatt Four Corners plant at Farmington, New Mexico which in early 1971 emitted over 465 tons of particulates each day and whose plume of pollution could be traced back to the plant from a distance of 140 miles (25). The magnitude of the future problem can be foreseen when it is realized that several of the North Central Power Study plants proposed for Montana are two and a half to five times as large as the Farmington operation.

Much conflict exists concerning the effects of sulfur dioxide, a major emission from coal-burning operations. Evidence indicates that exposure to SO_2 has a retardation effect on plant growth and can be a threat to human health. Of sulfur dioxide in the air, President Nixon's February 1971 message to Congress states:

> Sulfur oxides are among the most damaging air pollutants. High levels of sulfur oxides have been linked to increased incidence of such diseases as bronchitis and lung cancer. In terms of human health, vegetation, and property, sulfur oxide emissions cost society billions annually.

Although we have not been able to locate any extensive studies concerning the effects of SO_2 on range vegetation, reports of deteriorated flora make it clear that injury can occur in areas of low annual concentrations when the sources of pollution and/or meteorological conditions are such that the threshold for injury is exceeded. Evidence also indicates chronic injury where concentrations never exceed 0.1 parts per million (24). One investigator, experimenting with the effect of SO_2 on rye grass, reported that yields grown in unfiltered air were significantly lower than similar plants grown in filtered air, with no visible symptoms in the plants. Sulfur dioxide levels ranged from 0.01 ppm to 0.06 ppm, with exposure periods ranging from 46 to 81 days (24).

At concentrations of about 0.05 ppm to 0.25 ppm, sulfur dioxide may react synergistically with ozone or nitrogen dioxide in short-term exposures to produce moderate to severe injury to sensitive plants. The damage caused by the combination of SO_2 and ozone or SO_2 and NO_2 is much more severe than would be a similar concentration of SO_2 and NO_2 individually (24).

These mine-mouth installations would also release large amounts of carbon dioxide as well as varying amounts of uranium, radium, thorium, mercury, cadmium, other heavy metals, and trace elements.

Direct emissions are not the only serious environmental problems created by mine-mouth plants. Blowdown water (water that has been used in cleaning the cooling mechanism) is highly charged with minerals that are capable of killing aquatic life and surface vegetation. These minerals can also contaminate ground water if leaching occurs. Spoilbanks are yet another source of dissolved solids if water in excess of the normal precipitation (10-15 inches) is applied. Fly ash, removed by the pollution control equipment and disposed in the spoils, contains a number of heavy metals and trace elements, including lead, zinc, copper, sulfur, and boron. These elements, toxic at certain levels, are evidently not inert when buried and exposed to water.

Transmission lines associated with mine-mouth plants are a major aesthetic intrusion on the landscape. Corridors, excavations, and access roads as well as the towers themselves cause not only visual but ecological degradation. Pipelines for water supply have similar though less severe impacts.

Conversion Plants and Multiproduct Complexes?

A multiproduct complex consists of one integrated operation to produce electricity, liquid and gaseous fuels, and petrochemicals. These plants would have a capacity of 1,000 megawatts of power generation, 50,000 to 100,000 barrels of liquid fuel per day, and 250 million cubic feet of gas per day. Each plant would consist of a carbonization section producing gas and liquid fuels and a hydrogenation unit producing synthetic crude oil. Char, a by-product of the carbonization process, is usable as a fuel in the power plant. A three-plant complex would require 50,000 to 75,000 acre-feet of water annually and 12.5 million to 18 million tons of coal (15). The tremendous water and coal requirements would probably limit the number of complexes in Montana to 12 or less (16).

Gasification would probably be the first type of coal conversion in Montana. A synthetic pipeline gas would have to be approximately the same quality as natural gas, meaning a heating value of 950-plus BTU's per cubic foot (19). Sixty-five gasification processes presently exist (21), but none can yet produce at a price competitive with natural gas. The German Lurgi process probably offers the most promise for commercial gasification because fewer steps are needed. It requires larger capital investments than other techniques but has been proven in more than 30 plants around the world, none in the United States.

Lurgi gasification plants may consist of four units (trains) having a total capacity of one billion cubic feet per day and requiring a total investment of about $1 billion. The trains located seven to 10 miles apart and each would consume about seven million tons of subbituminous coal as well as 17,000 acre-feet of water per year. This method makes more efficient use of the coal's original energy content than do steam electric installations. Steam generators transform 30 to 40 percent of the coal's heat into electricity, while the Lurgi coal to gas process has a 69-percent conversion factor (efficiency). Preliminary estimates indicate that Lurgi gas plants could be operable in the Fort Union area within the next decade.

Several companies have expressed interest in constructing one or more gasification units of 250 million cubic feet per day in Montana, but the intended gasification techniques have not yet been made public. In December of 1971 the HFC Oil Company of Casper, Wyoming requested 50,000 acre-feet of water from the Missouri River for future use in two or more gasification plants near Bloomfield in Dawson County. One may be constructed as early as 1974. Colorado Interstate Gas Company is slated to build a similar plant near Hardin, Montana. A proposed gasification plant near Sarpy Creek on the Crow Indian Reservation is expected to be operational by 1984 (22). Consolidation Coal Company is apparently also interested in constructing four gasification plants on the Northern Cheyenne Reservation (18). Coal requirements would probably remain about the same regardless of the process used, but water requirements could vary significantly. Some estimates of the water needs for a plant capacity of 250 million cubic feet per day go as high as 33,000 acre-feet per year.

Several coal liquefaction processes have been devised and are in various stages of development, but as yet are noncompetitive with petroleum products. These plants would have to produce approximately 100,000 barrels of liquid fuel per day and would consume annually 11 to 15 million tons of coal and 65,000 acre-feet of water (4, 21). No liquefaction plants are currently known to be planned for Montana.

The total instate population increase resulting from coal development might be 300 thousand to 400 thousand people (1,5). One multiproduct complex would employ more than 3,000 people and might create a city as large as 24,000, which is much larger than any present Montana city east of Billings (23).

The primary environmental problems created by multiproduct complexes would be the same as those previously mentioned.

Impact on the Human Environment

The human environment is made up of numerous systems including industrial, agricultural, residential, commercial, educational, recreational, and political, as well as systems of cultural amenities, communications, and transportation (5). All these systems are interrelated and any change within one is reflected by corresponding secondary changes in the others. It is therefore apparent that intensive large-scale development in a predominantly agricultural region would have far-reaching secondary repercussions.

The transition from an agrarian to an urban-industrial life style could be very rapid in some locations. In these areas the basic employment patterns would be changed, the traditional culture values disrupted, and existing land use relationships altered. Well-planned coal development could perhaps benefit some eastern Montana communities whose populations have declined rapidly in recent years, but such benefits might be short-range.

Industrialization creates an increased tax base at all levels. More income and more property are available for taxation, but the population increase also creates a greater demand and requires greater expenditures for all government services, including police and fire protection, sewage and solid waste disposal, and water. It also requires a larger number of educational facilities, an expanded political system, and a rethinking and modification of the entire transportation system. It means a greatly increased load on all existing recreation facilities and a demand for more.

The increased tax base is often temporary in the case of coal mining and coal-related industry. Unless reclamation is unusually successful and the land is restored to a productive condition, strip mining destroys the base: when the coal is depleted and the power companies move their plants closer to new fuel supplies, spoilbanks have little tax value. The present standard of living in the Appalachian coal fields demonstrates the long-range economic impact of indiscriminate mining. The coal and power companies have departed, leaving the people with no jobs and the government with nothing to tax. With exhaustion of Montana's coal reserves, a similar situation would almost certainly develop. The lifetime of proposed generating facilities for Montana coal development is estimated to be about 30 years.

The coal development area of the state may also be faced with the stress and frustration of urban living along with other related problems such as an increased crime rate, poverty, overcrowding, noise, congestion, and litter.

What Must Be Done?

The question of restricting mining only to carefully selected areas must be given serious consideration. Recent estimates by the Montana Bureau of Mines and Geology (10) indicate that it is unlikely more than six billion tons will be mined in Montana during the next 50 years, and that approximately 128,000 acres will be disturbed (10). Because strippable reserves far outnumber this total anticipated requirement, a state agency, such as the Department of Lands, should be granted the power of selective denial to assure that the coal is mined only in those areas in which land use conflicts are minimized. In heavily wooded areas such as the Bull Mountains and the Ashland district of the Custer National Forest, any type of mining would be very destructive, but the topography and relief are such that the coal seam is exposed on the valley walls, thus requiring the most ruinous of all opencut techniques, contour stripping. Restriction of mining in these areas would preserve an energy source usable in the event of a severe future shortage and if coal is only an interim solution to our energy problems these productive, scenic and historic areas might never have to be mined.

The present steam electric generators have half the efficiency of some other generation and conversion techniques, such as magnetohydrodynamics (MHD), now under study. Rapid development of these latter methods could render the present type of facilities obsolete in a short time. The long-range interests of Montana might best be served by delaying coal development for a number of years rather than irretrievably committing the state's resources to an inefficient, outdated technology.

The production of gaseous and liquid fuels might eventually have a greater impact on Montana coal fields than electric generation. Currently electricity fills only about 10 percent of the total United States energy needs, and the projected tenfold increase would bring the figure only to 25 percent (14). Unless some alternative liquid fuel and gas sources are developed, such as hydrogen fuel, the remaining 75 percent will have to continue to come from rapidly diminishing fossil fuels. Because Montana Fort Union coal is a vast supply of easily recoverable energy, conversion to synthetic fuels will probably impose additional demands on the region, beyond the requirements of the North Central Power Study and Bonneville Power Administration projections.

Long-term social and environmental degradation can be avoided only through a coordinated effort by all levels of government, the involved companies, and an interested public to formulate regional plans.

The federal government is involved in coal development through leasing (owns mineral rights on 55 percent of Montana's strippable coal), setting emission standards, approval of mining plans where federal coal is involved, the construction of water storage and conveyance facilities, and other projects (BPA planning and the North Central Power Study), but has only recently taken action to coordinate activities. A federal-state coal task force, entitled the Northern Great Plains Resource Program was established to assess the potential economic, social, and environmental impacts of development and to guide resource management decisions. The group, headquartered in Washington, D. C., will have representatives from the Department of Interior, Department of Agriculture, the Environmental Protection Agency, the Commerce Department, and the states. The Commerce Department and the five involved states (Montana, Wyoming, North Dakota, South Dakota, and Nebraska) will be represented through the Old West Regional Commission. The study group is still in the organizational phase.

A functional, soundly based regional plan relating to coal development requires a body of background information that is currently lacking. Urgently needed are:

1. A comprehensive study of effective reclamation practices.
2. A detailed analysis of Montana coal to determine the amount of trace elements and heavy metals present.
3. More work on the effects of SO_2 and other emissions on the rangeland ecology.
4. A study of the problems associated with burial of fly ash in spoilbanks.
5. An in-depth study of government and industry research priorities. It would be important to know how much is being spent on the search for more efficient and less degradatory means of electrical generation and transmission as well as for new generation techniques.
6. A comprehensive regional meteorological survey of the eastern one-third of the state.
7. Specific knowledge of the environmental problems involved in moving coal by slurry pipeline.

Above all, if the planning efforts of Montana and other coal reserve states are to have any hope of success, the most imperative needs are for state self-determination in resource use and for a national energy policy and a national program to moderate energy consumption by encouraging conservative rather than maximum energy use.

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STATE COAL LEASING POLICY

Coal found on state lands may be leased by competitive bid, under procedures established by the State Board of Land Commissioners. Present lease rentals are one dollar per acre for the first ten years of the lease and five dollars per acre for the second ten years. Royalty rates per ton are presently 15¢ for lignite and 17½¢ for subbituminous coal.

Interest in state owned coal has been and continues to be high. In Big Horn, Powder River, Rosebud and Treasure Counties, over 41,000 acres have been leased for coal. In 1972, the Department of State Lands received lease applications for 15,554 acres of state lands, primarily in Dawson and Powder River Counties.

For the following reasons, however, the Department has postponed coal lease sales until early this summer:

1. Although the Department has expended a great amount of effort in reviewing and revising the present state coal lease provision, it does not have adequate information to determine levels of rental and royalty that would insure "full market value" return to the trust. It is felt that the State of Montana should seek the maximum legitimate return from the development of the coal resource.

2. The Department is drafting legislation to strengthen reclamation requirements on all lands in Montana disturbed by surface mining. Therefore, it seems inappropriate to have a lease sale preceding the legislative session.

3. Uncertainty on the part of industries as to reclamation requirements could have a negative impact on bids.

4. Special study needs to be made of problems relating to the lease of state owned minerals where surface rights are privately owned.

A draft environmental impact statement will be filed prior to the sale of state coal leases. This will necessitate an inspection of each tract involved.

COAL MINING METHODS

A. Underground Mining Methods

Until much of the coal market disappeared with the advent of diesel power railroad locomotives, coal was mined underground in many Montana localities, including Red Lodge, Great Falls to Lewistown, Roundup, along the Highline and in many other areas. Today, only a few "family" mines near Roundup extract coal by underground methods, supplying heating coal to local markets. All may close because of strict application of federal mine safety standards.

Underground mining is generally more hazardous and costly than surface mining, and many companies claim their Montana deposits cannot be mined underground economically. Peabody Coal, however, does plan to operate a large underground coal mine near Price, Utah. This mine will supply all coal, some 3,300 tons daily, for the 2,000 megawatt (2,000,000 kilowatt) Huntington Canyon steam fired electrical generation plant presently under construction and scheduled for completion in 1974. The coal deposits of the southwest are in some respects quite similar to those in Montana's Fort Union formation.

B. Strip Mining

Strip mining, whether area mining or contour mining, employs draglines or shovels to remove the overburden from a coal deposit. Some companies use scrapers to remove the softer overburden. The coal and essentially all overlying material are drilled and blasted to facilitate removal. Draglines with fourteen to seventy-five yard buckets are being used in Montana or are on order. Loading shovels and/or endloaders load the coal upon trucks for haulage to processing facilities.

1. Area Strip Mining

All major Montana coal mines are "area" strip mines. Area strip mining operations are found in flat to gently rolling terrain. If underlain by coal, an entire basin may be mined. Mine boundaries may be determined by coal burn lines (from historical fires), property lines, or areas in which the overburden is presently considered too thick to remove economically. Some active operations are tentatively projected to remove up to one hundred fifty feet of overburden for a fifty foot coal seam.

In area mining, spoils from the first cut (box cut) are placed on undisturbed land to one side. Mining then proceeds across the area in a series of parallel cuts, with the overburden from one cut being placed in the void created by the previous cut.

The bulk of the mined area can be rather easily recontoured to acceptable grades. Problem areas, in terms of grading and "dirt work" are the box cut spoils, the highwall (rock face left after the final cut), and the areas adjacent to haul roads routed through spoils ridges.

2. Contour Strip Mining

Contour methods are used in hilly or mountainous terrain where coal seams crop out on slopes. This is the mining method characteristic of Appalachia. In many areas, increased overburden thicknesses allow for only one or two cuts to be made economically. As the name implies, contour strip mining follows the contour of the land, with mining operations following the coal along the hillside, commonly throughout a drainage. The entire mine area presents grading and stability problems.

Unless mining methods are regulated, spoils from the first cut will be placed in the "logical" location -- down the sidehill. Much additional acreage not underlain by coal will be disturbed, often with tragic results. When large volumes of material are placed on a sidehill, much of it will have to remain at the "angle of repose" (angle at which the material falls and rests). Experience in Montana indicates that spoils at the angle of repose are almost impossible to revegetate and are a perpetual source of sediment to drainages below.

Further, since only a few cuts are made, highwalls will occupy a relatively large percentage of the mined area. These highwalls may prove very difficult to reduce (slope back) because of hillside terrain above. To slope highwalls in hilly terrain, much additional land above the highwall must be disturbed. Without reduction, highwalls remain a permanent, highly visible scar in the drainage and constitute an impassable barrier and hazard to humans, livestock and big game.

Modified contour strip mining operations are proposed by Consolidation Coal Company for the Bull Mountain Area of Musselshell County. Other companies may propose contour mining operations for other Eastern Montana areas of similar topography.

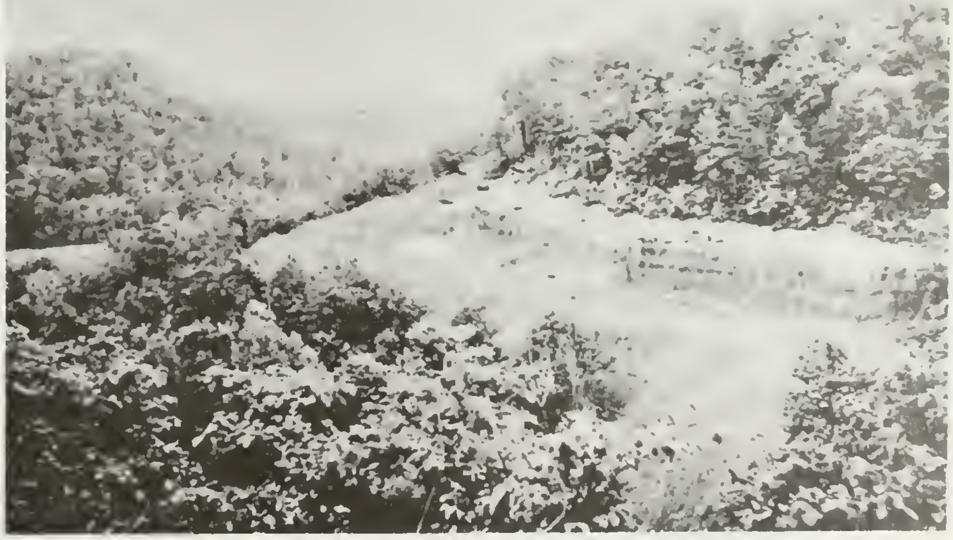
C. Auger Mining

Auger mining is used most commonly in conjunction with strip mining operations. Coal augers with bits up to seven feet in diameter are set up along the highwall to "drill out" as much coal as possible before final grading. Recovery is generally less than thirty percent of the seam. However, much of the coal mined by auger methods would not be removed by other methods. Unless subsidence problems occur, augering disturbs no additional surface.

No augering is underway in Montana. Experience in the East shows that the chief environmental problem is the possible degradation of water quality by waters discharged from auger holes drilled up grade on an inclined coal bed.

AREA STRIP MINING Area strip mining, method used in gently rolling to flat terrain. Photo shows overburden removal on new boxcut at Western Energy mine. Coal exposed at bottom of cut. (State Land photo)

CONTOUR STRIP MINING Contour strip mining, used on rolling to very steep topography. It creates a bench which follows the contour line. The overburden is cast on the outer edge of the bench. Sloughing of the spoil material is common. (Kentucky photo)



AUGERING Auger mining, used to recover coal that cannot be profitably stripped. The coal seam is about four feet thick. (Kentucky photo)

RECLAMATION OF LANDS STRIP MINED FOR COAL

Introduction

In early days of strip mining, the land was abandoned as the dragline left it. Because of slope, soil and moisture problems such spoil ridges remain unproductive after forty years. Public policy in Montana now demands that mining disturbances be reclaimed to a productive use and that damages to other resource values (agricultural, archaeologic, historic, scenic, hydrologic, wildlife, fisheries, etc.) be minimized or eliminated. Reclamation poses complex and inter-related biological, chemical and physical problems, many of which are unique to a given mine site.

State Legislative Requirements

The Montana Legislature, like those in most eastern coal mining states, has passed a series of strip mine reclamation laws, each statute imposing controls or standards more stringent than those previously enacted. Relevant 1967, 1969, and 1971 statutes are hereinafter discussed, and the need for stronger legislation to be considered by the 1973 assembly will be documented.

1967 Legislation: Coal Mining - Reclamation of Lands, 50-1001 to 50-1004, R.C.M., 1947

The 1967 legislation was the state's first attempt to regulate the surface mining of coal. The Act provided for "voluntary" contracts to be entered into by and between the Montana Bureau of Mines and Geology and the mining company. These reclamation contracts which were not mandatory, allowed the company to apply half of the reclamation costs incurred as a tax credit toward the coal mine license tax.

Five voluntary contracts were issued, two of which concern the same operation. Only one is covered by a surety bond to assure that the reclamation commitments are kept. This shortcoming is rather inconsequential since there are few definite commitments to be met. For example, one such voluntary contract contains the following grading and revegetation provisions:

> Section 3. Grading: Operator shall perform grading on any mined lands abutting any Federal Aid Interstate Defense, primary or secondary highway by striking off ridges for a distance of one hundred (100) feet from the highway side of such lands, to a width of at least ten (10) feet at the top and peaks to a width of at least fifteen (15) feet at the top. In all cases, an even or gently undulating skyline will be a major objective.

> Excerpt from revegetation section: On any affected land whose chemical and physical characteristics are toxic, deficient in moisture or plant nutrients, or composed of sand, gravel, shale or stone to such an extent as to seriously inhibit plant growth in the opinion of Operator and Coordinator, planting shall be held in abeyance for a period of ten (10) years after the mining is completed. If, during this ten (10) year period, natural weathering and leaching of such affected lands fails to remove the toxic and physical characteristics inhibitory to plant growth, the affected land will be considered unplantable. (emphasis added)

With no topsoil salvage provisions, no materials other than "sand, gravel, shale or stone" could be left at the surface by conventional mining procedures. Further, essentially no productive vegetation has been established at the subject mine site -- in spite of repeated company seeding programs.

It should be noted, however, that all four companies presently mining coal under the 1967 "voluntary" contracts (Western Energy Co., Peabody Coal Co., Knife River Coal Mining Co., and the Decker Coal Co.) have initiated reclamation procedures that go well beyond the grading and revegetation standards set by the contracts.

1969 Legislation: An Act to Provide for the Reclamation of Strip Coal Mined Land and to Declare a Penalty, 50-1005 to 50-1017, R.C.M., 1947

This act served primarily to make the obtaining of 1967 style voluntary contracts mandatory for coal mining companies. In that all subject companies obtained such a contract prior to the 1969 legislation's effective date, this law was not officially implemented.

1971 Legislation: The Montana Open Cut or Strip Mined Land Reclamation Act, Chapter 10, Title 50, R.C.M., 1947

The 1971 legislation, which repealed the 1967 and 1969 Acts discussed above, is the first significant strip mine control measure enacted in Montana. Chapter 10 regulates surface mining operations for sand, gravel, clay, uranium, bentonite and phosphate, as well as for coal. Administered by the Department of State Lands and providing for substantial fines, the law makes it mandatory that operations removing over ten thousand yards of product (commodities listed above) or overburden be covered by a "model" reclamation contract. This "model" contract was developed after lengthy study and review by a subcommittee of the Governor's Council on Natural Resources.

The contract in turn requires that a detailed reclamation plan be submitted to, and approved by, the Department of State Lands before mining can commence. The acres to be disturbed in any given contract year must be bonded in an amount sufficient to cover the cost of all reclamation commitments made.

Some of the minimum reclamation plan commitments that the contract requires were written rather loosely. For instance, a plan may not be approved unless:

> Section II part e. To accomplish practical utilization of soil materials, such material will be utilized for placement on disturbed areas if required by the reclamation plan after completion or termination of that particular phase of the mining operations at a depth sufficient for plant growth on slopes of 2:1 or less. Grading specifications shall be commensurate with the topography sought and land use designated.

"Soils materials" are defined as topsoil and/or non-toxic spoils. The section does not unequivocally state that soils materials will be salvaged or that all slopes will be two to one or less. Furthermore, two (horizontal) to one (vertical) slopes are in most cases too steep for adequate revegetation -- especially on south or west facing slopes.

In light of such ambiguities, most of what the Department of State Lands has accomplished in negotiations with coal companies and other mineral producers can be attributed to a general mandate set forth in Section I of the "model" contract:

> The Commission may approve a reclamation plan only if the Commission has found that the plan provides for the best possible reclamation procedures available under the circumstances at the time, so that after mining operations are completed the affected lands shall be reclaimed to a productive use.

This provision grants broad discretionary authority to the Department. It has inevitably prompted many Department-Operator discussions over what in fact constitutes the "best possible reclamation." Topsoil salvage, grading requirements, and highwall reduction have been salient areas of contention.

The 1971 Montana Open Cut or Strip Mined Land Reclamation Act does not provide for periodic review of reclamation procedures, prohibition of strip mining in any area for any reason, or control of mining methods. Other shortcomings of the act will be outlined in following sections of this report.

Coal Company Compliance with State Reclamation Laws

Major Operations. The 1971 Montana Open Cut or Strip Mined Land Reclamation Act excludes all operations covered by "voluntary" contracts - giving them a "grandfather" status. All major coal operations currently underway in Montana (Decker, Knife River, Western Energy, Peabody) are operating under 1967 contracts. Knife River Co. obtained the first voluntary contract on July 1, 1967. Three of the companies have submitted applications for the more stringent 1971 contracts. Western Energy has not applied but has made significant improvements in its reclamation program in 1972.

No 1971 style contracts have been issued to major, currently active, coal operations. In the case of active coal operations, contract execution must be delayed until a satisfactory reclamation plan has been negotiated. No final agreements have been made. Further, compliance with the Montana Environmental Policy Act requires that an environmental impact statement be prepared prior to the issuance of reclamation contracts for major mining operations. Some of the companies have not yet submitted requested data so that the Department of State Lands can prepare an adequate statement.

Some companies have taken truly voluntary steps toward compliance with standards more stringent than their voluntary contracts require. Another company did so only after the Department of Natural Resources and Conservation served notice of intent to cancel the voluntary contract. That company has recently initiated topsoil salvage operations and has modified its mining method so that unproductive shales will be placed well below the surface of graded spoils.

Westmoreland Resources, Inc. has applied for a reclamation contract pursuant to the 1971 law and has submitted preliminary data to be used in the preparation of an environmental impact statement. The company is incorporating reclamation planning into its mining operation, which is projected to begin in April, 1974. Its application is being revised in response to a number of technical requests made by the Reclamation Division of the Department of State Lands.

Since the particulars regarding a coal company's progress in achieving acceptable reclamation may change rapidly, this report will not detail information about any given mine site. All coal company files are open and may be inspected by anyone. Specific questions may be addressed to Department of State Lands' staff.

Small Operations: Three "family" mines in the Roundup area have fully complied with the Montana Open Cut or Strip Mined Land Reclamation Act. Two have commenced stripping operations; one is soon to start. These operations, which supply local heating coal, involve a total of less than 23 acres and use scrapers to remove overburden.

Mining activity at Consolidation Coal Company's controversial Bull Mountain test pit (15 acres) was in compliance with 1971 law and is now complete. Spoils areas have been graded to a series of experimental slopes, from flat to angle of repose. Highwalls were reduced. (This was relatively easy because of the test pit's location in a broad, gently-sloping saddle.) Spoils plots were alternatively surfaced with salvaged topsoil, sandstone, and a sandstone shale mixture. Fall evaluation of this spring's seeding shows topsoil producing by far the best ground cover and shale the worst, with better results obtained on gentle slopes.

Reclamation Costs per Acre and per Ton: Appendix I, attached, is a graph relating various coal seam thicknesses to costs of reclamation in terms of cents per ton of coal. Assumptions are that reclamation costs one thousand dollars per acre and that an acre foot of coal contains 1,760 tons.

Coal seam thicknesses at active or proposed mines are: 16 feet at Knife River's Savage Mine, 26 feet at Western Energy's Rosebud Mine (Colstrip - one seam), 34 feet at Peabody's Big Sky Mine (Colstrip - two seams being mined), 50 feet at the Decker Coal Company's Decker Mine and 52 feet at Westmoreland Resources' proposed Sarpy Creek mine. Consolidation Coal Company's Bull Mountain test pit mined a nine foot seam.

For Montana coal mines, reclamation costs are only a few cents per ton. The United Mine Workers' Pension Plan takes 20 to 40 cents per ton on certain mine sites and railroad freight rates to midwestern power plants reportedly range between six and eight dollars per ton. Therefore, reclamation costs obviously are not prohibitive.

Topsoil salvage and grading activities contribute eighty to ninety percent of the total reclamation costs incurred on area strip mined spoils. For instance, Department of State Lands' cost estimates indicate that a contractor could profitably salvage six inches of surface soil materials (picking it up, moving it one mile and respreading it) at a cost of four hundred dollars per acre. Grading costs are in the same range.

We know relatively little about reclamation costs involving contour strip mining. The costs may vary significantly, depending upon the mining method employed.

Standards (area strip mining) Sought by the Department of State Lands

Most coal mine disturbances are to be reclaimed for domestic grazing and wildlife. The Reclamation Division has notified each company that major reclamation requirements will be:

1. Salvage of all valuable surface soils materials to the extent that all disturbances are retopsoiled to depths averaging six to eight inches. This requires detailed soil surveys to assure that the best materials are saved and that excessively saline soils are not.

2. General maintenance of 5:1 (twenty percent) slopes or less throughout the mine area. Box cut spoils and areas peripheral to haul roads pose special problems and require case by case treatment.

3. General reduction of highwalls to slopes of 3:1 or less. The additional area disturbed can be minimized by (a) grading the last cut's spoils toward the highwall covering part of the base, (b) blasting a wedge of material from the top of the highwall, and (c) covering the remaining

exposed highwall with the loosened material. Highwall reduction is more difficult in steep terrain bordering an area mine, involving problems similar to those encountered in contour stripping. As mine site hydrology allows, isolated highwall segments may be left standing with little modification to allow the final cut to fill with water valuable to stock and wildlife.

4. Revegetation in keeping with the proposed reclaimed use. Wildlife plantings pose particular problems, for little is known of the techniques. Only a few species valuable for wildlife browse are commercially available as seed or seedlings.

5. Preservation of water quality. The problems relate to potential siltation of surface waters and to increased salinities of both surface and underground water.

Feasibility of Reclamation

Some lands currently being strip mined for coal can be reclaimed. Other lands can be satisfactorily reclaimed only if mining methods are changed. Certain mining procedures essentially disregard reclamation possibilities. Further, it is doubtful that some lands tentatively proposed for strip mining can be reclaimed regardless of the surface mining method employed. Determination of whether land can or cannot be adequately reclaimed must be made on a site by site basis.

All concerned have much to learn. Little is known about the durability of vegetation established on a mine site when that vegetation is subjected to a grazing use. Because there is no livestock on any reclaimed lands that have been mined for coal in Montana, reclaimed land has yet to stand the test of use.

An evaluation of Montana's reclamation situation by a member of the U.S. Environmental Protection Agency is attached as Appendix II.

Proposed New Legislation

The Department of State Lands has prepared a rough draft of legislation to meet needs identified during its administration of the 1971 Montana Open Cut or Strip Mined Land Reclamation Act. As of the writing of this report, the draft is being revised in response to comments solicited from universities, coal and other mineral producers, environmental leaders, and state and federal officials. Appendix III outlines the salient features of the proposed new act, which features are still subject to change. The draft act covers clay, coal, uranium, bentonite and phosphate operations. It provides for flesibility in dealing with small operations, such as family operated coal mines or sand and gravel pits. The minimum bonding level for each operation is $2,000.00, and for operations involving 10 acres or more a bonding minimum of $200.00 to a maximum of $5,000 for each additional acre, as determined by the Board of State Land Commissioners, will be required. However, under certain circumstances the minimum bond requirements can be waived.

Conclusion

Some companies mining in Montana have displayed an exceptional spirit of cooperation and have demonstrated a desire to accomplish acceptable reclamation. Other operators, however, very likely will reclaim land only to the extent that they are required by law.

Relevent federal legislation still awaits passage. Federal agency enforcement of reclamation provisions on federal coal mine leases has not been uniformly effective (Ref. - United States General Accounting Office reports).

Therefore, the quality of reclamation in Montana apparently will be determined by Montanans. In light of the projected expansion of coal development new surface mining legislation is needed now.

To assure adequate mined land reclamation, the enforcement agency must rely upon four factors:

1. public concern and support;
2. department and administration commitment;
3. an adequate resource data base;
4. a stringent law with enforcement powers, adequately funded.

Montana has the first two.

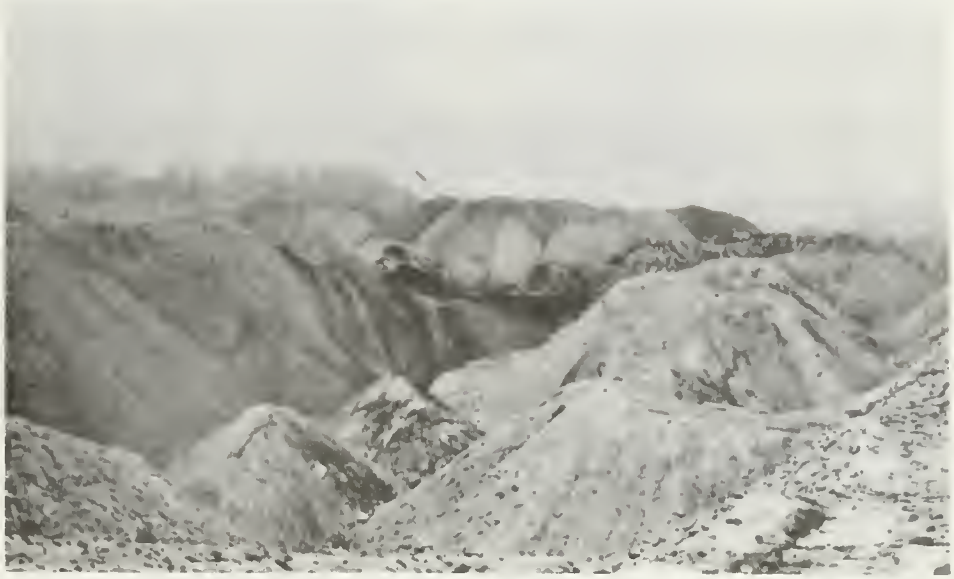
ILLUSTRATIONS

RECLAMATION WORK - Western Energy The foreground area has been graded and reseeded. The vegetation present (annuals) here provides microclimate and erosion control. Slower growing perennial grasses are hidden from view. Success of revegetation effort cannot be determined until perennials are fully established in the coming growing seasons. (Fish & Game photo)

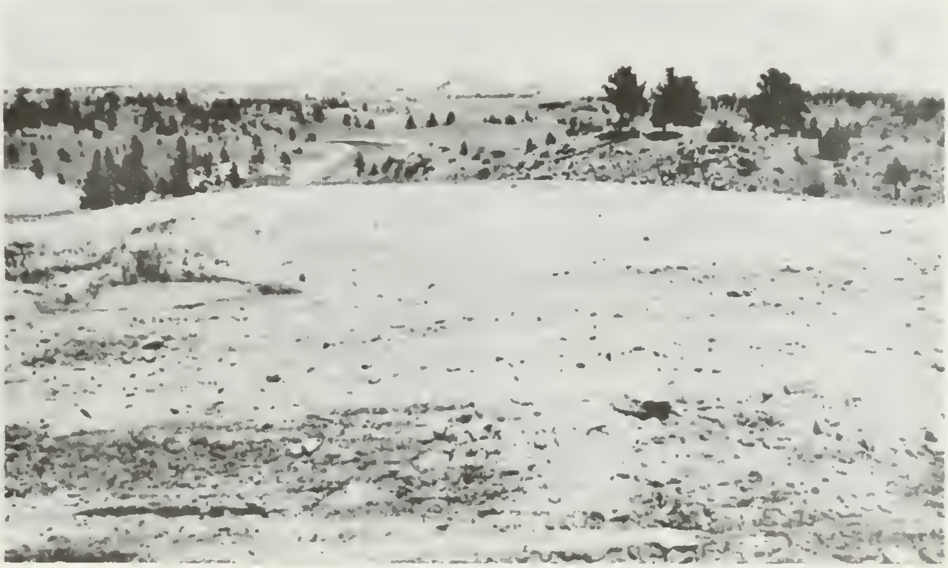
RECLAMATION EXPERIMENTAL - Plots Western Energy These mine spoils have been regraded. Reclamation experimentation is being conducted. The plots in the background have various topsoil depths, fertilizer treatments and other variables affecting revegetation. Light areas are untopsoiled. They eventually gullied because of thinner plant cover. (Fish & Game photo)

SAVING TOPSOIL - Decker At the Decker mine site, topsoil is removed ahead of the dragline and stockpiled for future reclamation work. As mining progresses and reclamation is started, the topsoil will be hauled directly to the regraded spoils avoiding the stockpiling. This will avoid handling the material twice. (State Land photo)

AREA STRIP MINE SPOILS Area mine spoils such as these need to be regraded and contoured. Long continuous slopes must be broken up and drainage systems provided. Haul roads pose serious problems in that their maintenance prevents prompt grading of nearby spoils.
(State Land photo)



REGRADED MINE SPOIL Untopsoiled Spoil area similar to that above after grading and seeding. Water infiltration is a problem and revegetation has been a failure. The shale material left at the surface is not conducive to plant growth. The State does not have the authority to require mining method changes that will bury the shale.
(State Land photo)

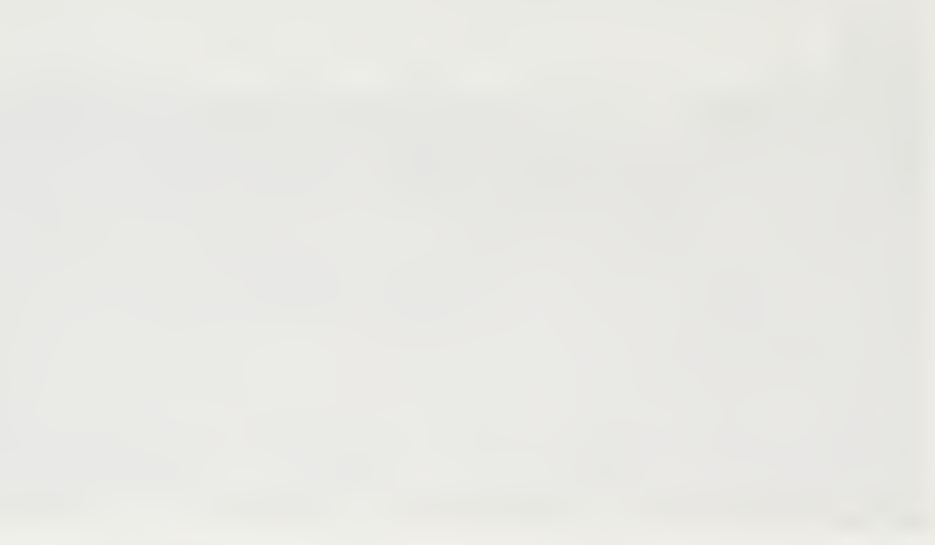


SLIDE OF OVERBURDEN MATERIAL From contour stripping. The outer edge of a bench made by contour stripping is subject to increased erosion. Landslides are common. Proposed new legislation will provide for controls of this type of mining.
(Kentucky photo)

SARPY CREEK This portion of the Sarpy Creek mine site will be disturbed by haul roads and related construction. Note mixed grassland-conifer vegetal type.
(State Land photo)

SARPY CREEK - Future Mine Site
Another portion of the proposed Sarpy Creek mine site. Applications presented to the Department of State Lands involve an initial 800 acres of a 34,000 acre lease.
(State Land photo)

TYPICAL TOPOGRAPHY OF BULL MOUNTAINS - Reclamation would be problem. Bull Mountain area underlain by strippable coal. Mining here would follow the contour stripping method and would be difficult to control.
(Fish & Game photo)



WATER RESOURCES

Introduction

One of the most significant coal-development issues is the prospect of massive consumption of water from the Yellowstone River and tributaries. The U.S. Bureau of Reclamation projects a possible annual water requirement of 2.6 million acre feet. This volume represents 29.7 percent of the river's average annual discharge (8.8 million acre feet per year), and in a dry year, such as those experienced in the early sixties, the river's annual discharge might be only half that figure. The same projected level of consumption would leave 1.8 million acre feet of water in the river in such a year, or 20.5 percent of the average flow. Once such industrial water consumption commences, it may be expected to continue regardless of the flow conditions in the Yellowstone River System. The marketplace will continue to demand power.

These massive new water uses would have an impact upon agriculture (especially irrigation), fisheries, recreation, aesthetics and possibly tourism. Little is known about what actual levels of water consumption will be reached, the timing of the use, or the magnitude of the various impacts to be incurred.

Coal-Related Supply/Demand Considerations

The development of coal in mine-mouth operations for thermal electric generation, MHD conversion to electricity, gasification, liquification or transportation by pipeline in slurry form all require water. In addition, the influx of new people, the growth of communities, and the information of new communities all mean increased demands for water. As water is transferred from current uses or withdrawn from surface or underground sources, a wide range of both noticeable and subtle changes will occur.

The Coal Task Force does not pretend to be able to predict what will happen or what the direct and indirect impacts will be. The intention is to provide a general basis for estimating water "requirements" for different levels and types of industrial development and for estimating changes in municipal demands as a result of increased population. In addition, a qualitative discussion of values which may be affected by changes in resource use patterns is included.

A. Industrial

The most imminent new water demand is for cooling thermal electric generating plants. In 1965 Dr. Allen Kneese of Resources for the Future states, "By far the largest of the industrial demands on water is that of steam electric generation. Steam power plants withdraw over twice as much as all other industries combined, and most of this water is used for cooling." In the middle 70's in Montana's coal fields, thermal electric generation and other types of energy conversion and transportation may make large demands on our water resource base.

The following table summarizes estimated water requirements for coal development.

TABLE: Estimated Water Requirements for Coal Development

Process	Capacity (units)	Total Annual Water reqts. (acre-feet)	Source
Steam-electric generation			
	700 megawatts	12,900	M.P.Co. EIS 1/
	1,000 MW	9,500-17,000	M/W A.S. 2/
	1,000 MW	20,272	NCPS 3/
	3,000 MW	50,000	NCPS
	6,000 MW	103,000	NCPS
	20,000 MW	342,000	NCPS
	50,000 MW	855,000	NCPS
Gasification	250 million ft^3/day	20,000-30,000	NCPS
Lurgi Process	250 million ft^3/day	10,000-17,000	
Hydrogenation	100,000 Bbl/Day	20,000-65,000	NCPS

1/ Montana Power Co. Environmental Impact Statement for the Colstrip Generating Complex, 1972.

2/ Montana-Wyoming Aqueduct Study, U.S. Bureau of Reclamation, 1972.

3/ North Central Power Study, U.S. Department of the Interior, 1971.

Although there is no firm source of information as to what is planned by energy companies, by making some assumptions possible water use levels can be estimated. According to the press, at least two companies are considering employing the Lurgi coal gasification process to produce a billion cubic feet of pipeline quality gas per day, presumably using 68,000 acre feet of water a year. Assuming 50,000 MW thermal generation (using 855,000 acre feet) and five coal gasification complexes (each using 68,000 acre feet) projected annual water consumption comes to approximately 1.2 million acre feet. Thus, depending on the level of generation and gasification development, as well as other coal-related industrial development (coal slurry pipelines, liquification or chemical processing), actual consumption may approach only half of the higher projection (2.6 million acre feet per year).

Water Use Alternatives

When discussing industrial "requirements" it must be mentioned that for cooling and for certain other uses there is no absolute requirement for a certain quantity of water. Depending on the cost and availability of water to the energy producer, the water-use technology is flexible until the plant is constructed. The North Central Power Study (NCPS) reports that if the price of delivered water should rise above $154 per acre foot, dry cooling processes, which use much less water, compete with wet cooling facilities. For much of its analysis, the NCPS assumed that water would be inexpensive enough to make wet cooling the desirable alternative.

According to numerous sources, dry cooling increases both construction and operating costs of thermal generating plants. When the possible high cost of providing water is included, however, the advantages of wet cooling diminish. Estimated increased capital costs of dry cooling for 53,000 MW are $742 million. This is, however, not even half of the $1.7 billion which the U.S. Bureau of Reclamation estimates their water development proposal will cost. 1/

One source estimates dry cooling will mean an increase of 2-5 percent in delivered cost of power.

Cooling steam generation facilities is expensive. One method (dry cooling) involves high capital costs ultimately borne by the consumer. When the construction cost of water development and delivery is added to plant costs, wet cooling apparently involves higher construction costs, some of which may be borne by government. In addition, significant hidden costs related to water becoming unavailable for other uses are likely to be associated with wet cooling processes.

The State of Montana has no authority regarding the nature of cooling facilities used for steam generation plants. Determination of the necessity for such control depends in part upon water use agreements already negotiated, the availability of alternative ground water supplies, needed water law reform, and municipal, agricultural, fisheries and recreational water needs. Also critical is an evaluation of the State's limited ability to quantify water requirements of other uses. These topics are examined in the following discussion.

B. Agricultural, Domestic, and Municipal

Large-scale coal development can mean many changes in non-industrial water using sectors of the economy. Changes in the size and distribution

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1/ U.S.B.R., Preliminary budget proposal to Congress.

of urban and rural population and in the agricultural land and livestock base will mean changes in water demands. Coal interests may buy irrigated lands in order to acquire the water rights. In order to provide a basis for estimating changes in water and related land resource use, existing water use patterns have been summarized.

TABLE: Water Use in the Fort Union Region of Montana; Municipal, Domestic, Agriculture

County	Population	Municipal/Domestic water use (A.F./yr.)	Irrigated Acres	Irrigation Diversion Reqt.	Irrigation Consumption (A.F./yr.) 2/	Livestock water use (A.F./yr.)
Big Horn	10,057	1,388	65,569	255,719	177,036	1,625
Custer	12,174	2,535	37,343	145,678	100,826	1,024
Powder R.	2,862	329	33,186	129,425	89,602	942
Rosebud	6,032	839	27,376	106,766	73,915	1,062
TOTAL	31,125	5,091	163,474	637,588	441,379	4,653

In communities located in the area, average daily water consumption ranges from 110 gallons per capita day (gpcd) in Broadus to 214 gpcd in Miles City.

C. Environmental and Aesthetic

If coal-related water demands remove large quantities of water from the current resource base, there will be consequences to human and environmental values. Until more is known as to the likely timing and magnitude of these demands, the resulting effects on physical, natural, and human systems can only be speculated upon. It does not require any specialized training, however, to realize that the natural environment and the present quality of life within the region stand to suffer potentially great adverse impacts. By wisely using existing programs, personnel, and legislation, the State of Montana can do much to better understand and deal with present and future changes.

Availability of Water Resources

A. Surface Waters

At the present there are 13 continuous-recording gaging stations on the lower Yellowstone and its major tributaries operated by the U.S.

2/ Assumes 2.70 A.F./Acre - based on USGS and U.S. Bureau of Reclamation estimates.

Geological Survey. In addition, the Department of Natural Resources and Conservation operates three seasonal stations on the Tongue River. The complete listing of all available records in the region may be found in USGS Circular 656, Index of Surface Water Records, Part 6. - Missouri River Basin.

Following is a table listing historical yield at several of the major stations in the region:

TABLE: Historical flow and yield, Selected points in the Yellowstone River System.

Station	Flow (Cubic Feet/Second)			Yield (Acre-Feet/Year)		
	Maximum	Minimum	Average	Maximum	Minimum	Average
Yellowstone at Billings	66,100	430	6,754	7,396,000	2,915,000	4,893,00
Bighorn at Bighorn	26,200	275	3,756	3,983,000	1,175,000	2,721,00
Tongue at Miles City	13,300	0	405	525,900	41,450	293,40
Yellowstone at Miles City	96,300	996	11,140	12,000,000	4,446,000	8,071,00
Powder near Locate	31,000	0	600	1,178,000	57,510	434,70
Yellowstone near Sidney	159,000	470	12,910	18,420,000	4,260,000	9,353,00

B. Ground Water Resources

Ground water throughout the area is variable in both quality and quantity. Most alluvial gravels under perennial streams are capable of producing water in sufficient quantities to facilitate irrigation and small industry, but sizeable withdrawals of this subsurface water would significantly reduce stream flow. Well yields from the upper sandstone and coal aquifers are generally less than 30 gallons per minute. The deeper aquifers are characterized by low to moderate volumes of water with enough quality problems to make them unacceptable for most uses. Depending on the aquifer, ground water may contain Na or Ca salts or contamination from oil and gas deposits.

Allocation of Water Resources

While water resources are not fully consumed by out-of-stream users, there are considerations which limit the actual availability of water resources for diversion and use. These factors include (a) requirements under the Yellowstone River Compact, (b) water rights, including those of Indians, and (c) water currently provided or optioned through a contract with the State or Federal Governments.

A. Yellowstone River Compact

The Yellowstone River Compact is an interstate river compact approved in 1950 by Montana, Wyoming, and North Dakota for the purpose of establishing water rights and allocating water from the Yellowstone River and its tributaries.

The compact recognizes all water rights prior to 1950 and sets up percentage shares for new (post-1950) appropriations. The table below shows these percentages.

TABLE: Water Allocation Under the Yellowstone River Compact

Stream	% to Montana	% to Wyoming
Clarks Fork of the Yellowstone	40	60
Bighorn (excludes Little Bighorn)	20	80
Tongue	60	40
Powder (includes Little Powder)	58	42

The provisions of the Yellowstone Compact have not been fully implemented in the past primarily due to a "surplus" of water. With great increases in the demand for water in the Yellowstone basin, Montana will have to gather extensive information on both pre- and post-1950 water use and rights.

B. Water Rights

Water availability and water rights, both on the surface and underground, will be key factors in the development of the vast coal resources in southeastern Montana.

Presently the State of Montana has no centralized administration of surface water rights. The "system" is basically left to each individual water user, with disputes being settled in local district courts. The Ground Water Code, passed in 1961, gives the State limited centralized administrative control over ground water rights.

The Department of Natural Resources and Conservation has a record of nearly 8,000 filed surface and ground water rights in the Fort Union Region of the Yellowstone Basin. Because all rights are not filed, the actual number of rights might be as high as 12,000.

The only systematic study of water rights in the state is the county water resources survey program of the Department of Natural Resources and Conservation. These reports, although useful, are only current to the completion of the study, which is usually one year prior to publication. The table below lists publication dates of selected county surveys.

TABLE: Publication Dates, County Water Resources Survey, Selected Montana Counties in the Fort Union Region

County	Year of County Survey
Bighorn	1947
Carter	1960

County	Year of County Survey
Custer	1948
Powder River	1961
Rosebud	1948
Treasure	1951

It is generally agreed by experts on Montana water law that the current system is inadequate in several respects. The lack of accurate and complete documentation of rights coupled with the non-existence of centralized records of rights result in uncertainty in an individual's water right. This uncertainty even extends to adjudicated streams. Under present law the burden of protecting his right in court lies with the individual. Not only does present law deny the public a voice in new uses of water, but it gives the state only a questionable right to become involved in legal water disputes with other states and the federal government.

Indian water rights (in this case, those claimed by the Crow and Northern Cheyenne) are uncertain in many respects. Some of the questions which should be resolved are: (a) How much land was intended to be irrigated when the reservation was set aside? (b) Was the original intent for agricultural uses (irrigation) only? (c) Can water on the reservation be switched from irrigation to replace that lost to industry? (e) If water is purchased for irrigation (3-4 months) can it be converted to industrial use on a 12 month basis? (f) Can Indians divert total amount (agriculture to industry) or only normal depletion (assuming that they can charge usage)?

C. Contracted or Optioned Water

Two major storage projects which could provide water for increased industrial and municipal demands are located in the area. These are the Yellowtail Dam in Big Horn County, owned by the U.S. Bureau of Reclamation, and the Tongue River Storage project in Rosebud County owned by the Department of Natural Resources and Conservation. As of April 1972, the Bureau of Reclamation had signed contracts with industrial firms for options on 623,000 of a possible 670,000 acre-feet of available water from the Big Horn reservoir (Yellowtail). In June 1972 the Montana Board of Natural Resources and Conservation approved a contract with Montana Power Co. for an option on 4,175 acre-feet of water from the Tongue River Reservoir. Presently all 40,000 acre-feet of dependable annual storage in the Tongue reservoir is contracted and the 4,175 A.F. to Montana Power is the only water allocated to industrial uses from the project. The 35,825 A.F. contracted to irrigation cannot be converted to industry without Department of Natural Resources and Conservation approval.

In 1967 the Bechtel Co. was contracted by the (then) Montana Water Resources Board to study the feasibility of raising the Tongue River dam or of constructing a higher dam downstream from the present site. An additional 60,000 A.F. could be provided by either alternative. No recommendations have been made by the State for the adoption of these or any other alternative enlargement proposals on the Tongue. The Bechtel study is available from the Department of Natural Resources and Conservation for review and use by any interested party.

This presentation is focused on Yellowstone Basin areas but there are also substantial coal deposits in the Musselshell drainage near Roundup and in the Missouri drainage near Circle. In the case of the Musselshell, state-owned projects could play a substantial role in providing water. In the Circle area, the preliminary feasibility study for an East-Central Montana Water Conservancy district has directed some attention to coal-related water development.

At present, there is no ongoing effort by the State of Montana to place itself in the role of developing water resources for coal-related industrial demands.

State Water Plan

The primary opportunity for the involvement of state government in the coal-related water resource development lies in the state water plan. Under the Montana Water Resources Act of 1967, the state is charged with coordinating all water development in the state and progressively formulating a state water plan for the maximum economic and social prosperity of its people.

In the five years since enactment of this law, several factors have become apparent. First, there is a need for comprehensive water planning for both in-state uses and for dealings with out-of-state demands for Montana water. An increasingly important aspect of state water planning has been the representation of Montana's interests in Federal and multi-state water planning activities. A second factor involves the apparent inadequacy of the law to provide the state water planning program with sufficient authority to require federal, local, or private planners to meaningfully cooperate with the state. In the case of coal development, there is not sufficient authority in the W.R.A. of 1967 to require the energy companies to give the state any advance information on their water development activities, to coordinate their activities to minimize environmental impact, or to design their water development in a manner which would be beneficial to other water users as well.

AIR AND WATER QUALITY

A large scale development of coal in eastern Montana will have various effects upon the physical environment. The air and water quality will be affected in a number of ways, some of which may be desirable and others undesirable. There are persons who are convinced that the worst possible conditions imaginable will become reality; others discount any undesirable effects as unworthy of concern.

Which impacts, both desirable and undesirable, are realized will depend upon a number of factors, including the formation of new legislation and regulations. Another factor is the enforcement of pertinent laws and regulations. With the current pace of activity relative to coal development in eastern Montana, agencies are finding their staffs hard pressed to keep abreast of the situation. Another factor which reduces the effectiveness of planning and decision making by various agencies is a scarcity of information in a number of areas related to the coal development.

Air and water quality come under the jurisdiction of the Department of Health and Environmental Sciences. The Department also has responsibility for enforcing regulations concerning domestic water supplies, radiation, sewage systems, food and drugs, solid wastes, and a number of other areas related to public health.

Air Quality

At present, most of the air over eastern Montana is virtually free of industrial air pollution. The concentration of air pollutants generated from such sources as certain agricultural practices, dusty roads, and a few light industries are generally well below ambient air quality standards. Days when visibility exceeds 50 miles are common.

Any use of coal in eastern Montana will contribute to a degradation of air quality until such time as total emission control is achieved. The kind and degree of degradation will depend upon the type and number of industries and supporting services that are established and the extent to which the emissions from all sources are controlled. An upper limit for the concentrations of various pollutants is defined by ambient air quality standards which should never be exceeded.

A number of pollutants, each of which will be discussed separately, are or may be emitted by coal fired installations.

Suspended Particulate Matter

Small particles of solid matter and small droplets of liquid (except water) in the air are referred to as suspended particulates. These particles can be over 100 microns in diameter to less than .01 micron. (One micron is about 1/25000 inch.) The concentration of suspended particulates is usually given in weight per unit volume of air. There are many particles for a given weight of particulates if the particles are small. (A particle that is .1 micron in diameter and of the same shape and composition as one 10 microns in diameter will weigh only 1/1,000,000 as much as the larger one.

Many activities and processes produce particulates, including the pollenation of plant life. Coal contains incombustable matter known as ash, part of which becomes airborne upon the burning of coal. Incompletely oxidized matter, such as soot, may also become airborne.

Technology exists to remove more than 99.5 percent (by weight) of the particulate from a coal fired power plant. Even with this efficiency, a 1000 MW plant will emit about four or five tons of particulate matter into the air each day, based upon 3.2 tons per day for a 700 MW plant. (The MPC plant in Billings emits about five tons per day, and the Trident Cement Plant emits 40 to 50 tons per day.) Because collecting devices are quite efficient in collecting larger particles but much less efficient in collecting smaller particles (less than one micron), the particles emitted into the atmosphere are small in size and large in number. These small particles have a greater effect on visibility and human health, and they remain airborne the longest.

One result of suspended particulates is the reduction of visibility. Particulates interfere with the passage of light through the atmosphere which allows one to see smoke and haze. The greatest effect of suspended particulates in eastern Montana, if a number of power plants are built, may be reduced visibility and blueness of the sky. No suitable means exist to adequately measure degradation of visibility. Because clouds, humidity, open burning, dust storms, and other conditions also limit visibility, that part which is attributable to power plants cannot be ascertained.

Sulfur Compounds

All coal contains some sulfur. Montana coals usually have less than one percent. When coal is burned in air, most of the sulfur is oxidized to sulfur dioxide (SO_2), a gas. Without any collection equipment, nearly all of the SO_2 that is formed is emitted into the atmosphere. Partial removal of SO_2 from flue gases can be accomplished in modern power plants. Based upon the predicted performance of the 700 MW plant at Colstrip (82 tons per day), about 130 tons SO_2 per 1000 MW of generating capacity will be emitted into the atmosphere per day. This figure conforms to the EPA standards for new power plants which would permit about 140 tons SO_2/day/1000 MW. For comparison, the smelter at East Helena emits about 300 tons SO_2/day, and the smelter at Anaconda emits about 1020 tons SO_2/day.

Sulfur dioxide in sufficient concentrations in the atmosphere has been shown to damage and kill many species of plants, to increase the rate of corrosion to manmade structures and substances, and to be a hazard to human health especially in combination with particulates. Sulfur dioxide reacts with other substances in the atmosphere to form other compounds. In several parts of the world, the presence of sulfur compounds in the air has been cited as one of the causes for increased acidity of rainfall. The increased acidity of rain may have some long term effects upon the ecosystem and will increase the rate of weathering upon manmade structures, especially those made of some metals, concrete, and marble.

In the Lurgi Process (the conversion of coal into gas), the sulfur in the coal is converted to hydrogen sulfide which can be easily removed from the gas stream. Hydrogen sulfide is produced in many industrial processes in which it is well controlled. Whether sulfur compounds will actually be released into the atmosphere from gasification plants is not known at this time.

Nitrogen Oxides

Nitrogen oxides (NO_x) are formed under conditions of high temperature combustion, especially in power plants and automobile engines. In the atmosphere, NO_x reacts with other pollutants in the presence of sunlight to produce photochemical oxidants, commonly known as smog (the variety of smog common to southern California). Control of NO_x production at present is accomplished in part by boiler design. Based upon the predictions concerning the Colstrip power plant (about 57 tons per day), a 1000 MW plant will emit about 80 tons NO_x/day. Ten thousand automobiles, with no control devices, running continuously would generate about this same amount of NO_x.

Organic Compounds

Due to the lack of experience concerning gasification plants in the U.S., neither the pollutants that will be generated nor their quantities are known. Company spokesmen have indicated that only water and carbon dioxide, neither of which is considered a pollutant, will be emitted from these plants. However, other industry sources have indicated that a number of compounds, some toxic, are generated in the process and may be released into the environment. If toxic compounds are released into the environment, it will be necessary to ensure that concentrations high enough to endanger the various ecosystems are not allowed. Much information is needed on the process of gasification and the potential impact on the environment that a gasification plant may have.

Fluorides

Most coal contains the element fluorine. Fluorides (compounds of fluorine) emitted into the air, which become incorporated into the flora and fauna, can be injurious to some species in rather small amounts. Plants and animals have been affected by fluoride emissions in at least two localities in Montana. There is some evidence that fluorine in coal can be emitted into the atmosphere (partly as hydrogen fluoride) from coal fired power plants. The amount of fluorine in Montana coal is not agreed upon at this time, but analyses have produced values as low as less than 1.0 ppm (parts per million) to 140 ppm.

The emission of fluorides by power plants, however, is not solely dependent upon the concentration of fluorine in the coal. Some air pollution control devices collect the fluoride and prevent its release into the atmosphere. The wet scrubber which is proposed for the Colstrip plant may remove more than 95 percent of the fluorides. An electrostatic precipitator, such as the one on the Billings Corette plant, would have less effect on the fluorides in the flue gas. The fluoride emissions from a power plant, such as the proposed Colstrip plant, are not known at this time, but it appears that there will be considerably less fluoride than from those industrial plants in Montana that have caused damage to the biological communities near them.

Trace Elements

Coal contains many elements in trace amounts. Even though these elements are in low concentrations, the large quantity of coal that is handled in a power or gasification plant results in an amount of the trace element which may be of concern. For example, if a particular element exists in the coal at a concentration of 1.0 ppm, the amount of that element that would pass through a 1,000 MW power plant in one year would be about three or four tons. A few tons of an innocuous element, as most are, will have insignificant impact if dispersed in the environment. A few tons of some elements, though, may cause environmental damage because of the ability of certain processes to concentrate these substances to toxic levels in the environment.

The concentrations of various trace elements in coal are poorly known. Another unknown factor in dealing with power and gasification plants is what happens to these elements in the plant and the amount and form of these substances released into the environment.

Radioactive trace elements make up one important group. The same questions arise concerning these trace elements as the others. The amount of radioactive material in coal and the percentage of this amount released to the atmosphere are not known. From best estimates at this time, it appears that radioactivity from power plants is not a problem, but efforts will be made to more accurately assess the situation.

There are many unanswered questions concerning trace elements, and the answers that come from the research now in progress will probably put some fears to rest while, at the same time, generating new ones.

Water Quality

Water quality may be affected in several ways by large scale coal development. Some of the more important concerns are listed herein.

Mining

Strip mining involves the movement of large amounts of rock over extensive areas. The removal of vegetation, disturbing of the surface, steeping of slopes, and activity of vehicles and machines promote erosion, which can increase the amount of sediment in streams and other surface water bodies. Some of the coal seams are aquifers, and water drains into the mines during operations. This water must be pumped out of the mine and may pollute other surface water if handled improperly. Some strip mines intersect aquifers, and groundwater flow patterns may change and cause regional changes in aquifer water pressures. Mines also may become points where pollutants can enter the groundwater system.

Power and Gasification Plants

Tremendous quantities of water are used in power plants, mostly for cooling. Gasification plants will also be great consumers of water. Water diversions may significantly alter the quality of surface waters by changing the quantity of water available for dilution or by mixing waters of different qualities. Water returned to streams may also affect water quality. Hot water entering a natural water body will alter the aquatic environment and may adversely affect the system. Chemical wastes that enter streams or other water bodies may seriously degrade the water quality. Collected ash from power plants contains many chemical elements and compounds, some of which may be toxic. The leaching of this ash, whether it is on the ground surface or buried in the mine, may release some of these materials into nearby waters.

Effects of Population

An increase in human population will occur in the Fort Union Region if the exploitation of coal is increased much over present levels. These additional people will require water supplies, sanitation facilities, and solid waste disposal sites if water pollution and public health problems are to be avoided. The building of structures, roads, housing, and community facilities may add to erosion problems already existing in some areas, which can increase sediment in surface waters.

Water Supply Schemes

Because the supply of water for use in a large number of power plants may ultimately limit the development of these plants, there will be a number of proposals to increase the amount of water available for industrial use. One proposal is to build a number of dams, storage ponds and aqueducts.

These impoundments may have both positive and negative effects on water quality. Another proposal might be weather modification to increase precipitation in the drainage basin. Depending upon the pattern of any increase in precipitation, weather modification may lead to erosion problems and greater siltation in surface waters. To reduce the water loss from evapotranspiration, there may be proposals advanced for the defoliation of vegetation, such as cottonwood trees, along valley bottoms.

FISH AND WILDLIFE RELATED PROBLEMS

Fisheries

From a fisheries standpoint, little difficulty has been encountered thus far in relation to the stripping and abandonment of the original surface mined coal lands at Colstrip. Areas previously mined were not of sufficient size to have a noticeable impact on water tables and drainage, consumption of water at the mine sites was not a major factor, and ponds that appeared in the final cut and other depressions on the mine sites experienced no severe problems that precluded survival of fish. However, present activities will quite likely create problems due to alteration of watershed characteristics and substantial consumptive water demands projected for the coal fields.

In November of 1972, eleven fish biologists who either have worked or are now working on segments of the Yellowstone River met to outline the problems of that river and its tributaries due to coal land development. Also established was an order of priorities for focusing attention on these concerns.

The first priority was to obtain an understanding of the aquatic ecosystem in the main stem of the Yellowstone River from Yellowstone Park through Big Timber. This river section was selected due to the apparent need for some type of water development for storage and flow regulation to meet the consumptive demands of the coal and power generation industries. At the present time the Montana Department of Fish and Game has a specific project designed to provide the necessary information, and it is not felt that any additional effort in this area is needed at this time. The project is financed entirely by Fish and Game funds.

Other areas where information is needed and increased effort definitely warranted are, in the order of importance: (1) fish population studies, Tongue River; (2) life history studies on nonsalmonid fish species inhabiting the mid and lower Yellowstone River; (3) fish population studies, Big Horn River; (4) fish and aquatic insect community evaluations, Yellowstone River from Billings to the North Dakota line; (5) inventory and basic life history data of forage fish species and invertebrates inhabiting aquatic ecosystems, lower Yellowstone River and its tributaries; (6) fish population sampling, Powder River; (7) dissolved oxygen analysis, Yellowstone River and its tributaries; and (8) accurate assessment of angling pressure, Yellowstone River and tributaries.

At the present time there is only a modest effort directed toward obtaining much of the data listed above. The factor limiting procurement of necessary data is financial resources. All the work presently underway is being done with Department of Fish and Game funds, plus a small grant from the Bureau of Reclamation to study the life history of sturgeon.

Wildlife

Since natural vegetative communities failed to invade and establish themselves on previously abandoned spoil piles, wildlife communities dependent upon native vegetation were essentially absent following earlier surface mining endeavors in the State of Montana. While no specific studies have ever been completed evaluating the impact of surface mining on wildlife communities, it is obvious that, if a plant community that wildlife depended upon was altered or destroyed, the wildlife species could not continue to exist.

Since 1969 the Montana Department of Fish and Game has attempted to initiate cooperative studies with coal mining interests to assess the impact of surface mining and reclamation on wildlife and also to provide data so that reclamation planning could realistically include techniques designed to restore vegetation that meets the needs of wildlife communities.

Since 1969 only one such study has been initiated. This basic wildlife ecology study, in progress since January of 1972, is located in the Bull Mountains and sponsored by the Montana Department of Fish and Game and Consolidation Coal Company.

Since November 1, 1972, the Montana Department of Fish and Game has reviewed environmental impact statements or environmental assessments on four major developments occurring on Montana coal fields. These include the Burlington Northern's proposed Sarpy Creek railway, the Knife River Coal Company's Savage Mine, the Montana Power Company's power plant development, and Westmoreland Resources' proposed mine. In all cases efforts were made to discuss the impact of these various projects on wildlife, and in all cases the analysis of the present wildlife situation and the projected impacts were found to be inadequate. In all cases strong letters of commentary were written, and copies of these letters can be obtained for review upon request.

All parties interested in developing Montana coal have displayed a willingness to discuss wildlife habitat as a purpose of reclamation; however, with only one exception, coal developers have made no substantial commitment to achieve that goal.

The Montana Department of Fish and Game, through the normal activities of its field personnel, has collected information on wildlife populations in and around the proposed coal developments for many years. Data previously collected related to the management of game species; i.e., setting seasons and regulating an orderly harvest by both Montana and nonresident hunters. To assess the effects of total disruption of wildlife habitats due to coal development, and to assist efforts to effectively reconstruct such habitats, more specific and intensified data is needed.

The problem of restoring suitable habitats for native fish and wildlife species is not currently a serious part of the reclamation effort. To date, most of the effort has been directed toward finding plant species that will survive on sites left after mining. To restore existing plant communities we must first understand the needs of the plants and then tailor reclamation to restore sites that will accommodate these plants. Little, if any, information currently exists on this topic.

The number one priority, therefore, regarding restoration of suitable wildlife habitats should be plant ecology studies that define the specific environmental needs of key plant species. Concurrent with this objective should be an inventory of both plant and wildlife communities and their interrelations. These studies would include the past influence of land use activities on plant and animal communities, the response of wildlife to habitat disturbance, and food habits, behavioral and territorial needs of wildlife species.

At the present time the only serious attempt of this nature is being conducted in the Bull Mountains, as previously mentioned. As in the instance of aquatic ecosystems, the need for financial assistance limits the ability of the Department of Fish and Game to become more deeply involved in the defense and restoration of healthy terrestrial environments. To ultimately restore the land's productivity for fish and wildlife, a much more serious and substantial effort must be made by both industry and the State of Montana. It must be a commitment not only to provide adequate financing, but it also must include the dedication of certain areas of reclaimed land for the primary use of wildlife production.

In addition to difficulties in providing for the basic habitat needs of the fish and wildlife resource, landowner-sportsmen problems will predictably increase with the increase in population.

ECONOMIC AND SOCIAL IMPACTS

In order to make a rational assessment of the economic and social impacts of present and future coal utilization on the people and the economy of Montana, it would be necessary first to know the location, nature, and timing of each planned use of the resource. In contrast to this detailed information, however, all that is available at this time are remnants of past surface and underground coal mining operations throughout the state; six surface-mining operations in eastern Montana in varying stages of development, all but two of which are now mining for export to out-of-state consumers; one comparatively large coal-based generating station under construction by Montana Power Company at Colstrip, which will export half of its ultimate energy output; and two or three prospective complexes that would use coal for conversion to natural gas, all of which would presumably be exported. In addition, there are studies, indications of actual but undisclosed plans, and speculations regarding other possible uses of the resource.

Most visible of these is the North Central Power Study, designated "phase I" of a possible project to build a complex of central power stations in eastern Montana, Wyoming, and the Dakotas to supply a share (53,000 MW) of the projected demand in 13 north-central states to the end of the century. Phase II of the project was to have begun with an indication, by some or all of the more than 30 utility companies that sponsored the study, of an interest in pursuing the matter further. Although a few reportedly have shown interest and others appear to be making individual plans, none has as yet disclosed plans.

Of the companies that have shown varying degrees of interest in locating coal-conversion plants in Montana to produce pipeline quality (high Btu) gas by the "Lurgi" process, two are utility companies in the natural gas transmission business. The two gas companies are weighing the advantages and disadvantages of alternative locations in Montana, Wyoming, and elesewhere. The other is a coal company (Consolidation) owned by Continental Oil Company. Its proposed plant location is reportedly the Northern Cheyenne Reservation, but the location and identity of its customer(s) for the gas have not been made known.

Other power generating plants anticipated for Montana are more nearly in the conjecture stage. Montana Power Company, whose electrical load in the state has been increasing at a rate about half that of national demand (repeatedly described as doubling approximately every 10 years), expects to have the Colstrip plant on line by 1976. If present trends continue, it will presumably then have to begin another and larger plant to satisfy the next increment of demand. Although, of course, the Bonneville Power Administration cannot speak for the Montana Power Company or its business partners, it has included in future plans for the Northwest Power Pool two additional 700 MW plants reported to go on line in 1978 and 1979 near Colstrip, with more than half the power destined for Puget Power and Light at that time.

The term "Economic and Social Impacts" is, of course, neutral and includes changes in the economic and social systems that may be evaluated by assigning them somewhere along a scale from "good" to "bad," with perhaps no two evaluators agreeing. The magnitude of such changes, however, can be determined with much more objectivity if the conditions are known. Some of the conditions that either are known or may be assumed for this discussion are these:

1. Coal Supply and Area

Although most of eastern Montana is underlain by coal at varying depths, in seams of varying numbers and thicknesses, and differing in composition and quality, the entire resource need not be taken into account at this time. Included in the discussion is only that portion of the state underlain by coal near enough the surface and occurring in beds thick enough to repay the effort of surface or strip mining. According to various sources, this means a surface area of some 800,000 acres in 14 eastern counties, with a total quantity of 20 billion or more tons. Another 10 billion tons probably underlies land owned by Indian tribes, but this is not subject to some of the known factors applying to the rest of the resource.

The 800,000 acres are owned partly by the state, partly by the United States government, and partly by corporations and private individuals. Rights to remove the coal are in most cases not vested in the owner of the surface, so that owners or purchasers of sub-surface mineral rights must either acquire or lease the surface in order to begin mining operations. Because of eminent domain, however, the surface owner's options do not include denying all offers if the holder of mineral rights chooses to go to court.

2. Prospective Uses

Coal is the source of hundreds of chemical products, many of which, however, can currently be derived from other sources somewhat more economically. Although chemical conversion remains a possible use of Montana coal supplies, the only uses that have so far been proposed are four in number:

a. Fuel to be used in distant furnaces.

b. Minemouth generation of power by turbogenerators.

c. Production of natural gas (Methane) for export.

d. Source of electrical power in conjunction with a Uranium enrichment plant.

Each of these coal uses makes a different impact on the physical environment, some of which have been noted in other sections of this report, and also affects the economy in different ways. More precise figures are needed, but at least a preliminary comparison can be made of the uses with regard to tax returns, use of coal and water resources, (discussed in another section of this report), and employment and population increases.

3. Tax Returns

Under present tax laws, coal using operations are subject to the following kinds of taxes and fees:

a. Strip Coal Mines License Tax -- paid quarterly to the state, based on gross value of tonnage mined and heat content of the coal. The first 5,000 tons are exempt from taxation. A credit may be claimed of either up to one cent per ton for land reclamation or one half the cost of reclamation, whichever is lower.

b. Corporation License -- paid annually to the state, based on 6.75 percent of all net income earned in the state, with a minimum of $50.

c. Net Proceeds -- paid to the county, based on tonnage mined. Net proceeds of mines and mining claims fall in Class 1 of taxable property, taxed at 100 percent of "full and true" value, after deduction of operating costs. Although it has the appearance of an advalorem property tax, this is in fact a tax on production.

d. Property, both personal and general (land and improvements) -- paid to the county. At the discretion of the Governor and with the approval of the electorate, a statewide property tax of up to 2 mills to be paid to the state may also be levied.

e. Royalties -- paid to the owner of the coal rights and currently reported to average about 17 1/2 cents per ton. In the case of federal land and/or federal mineral rights, 37.5 percent of royalties are returned to the state's school fund.

For coal-using companies, power generating and distributing firms are subject to the Electrical Energy Producers' License Tax, amounting to 1.438 percent of the gross value of electrical sales, as well as to corporate income taxes and property levies. No taxes peculiar to coal-conversion companies have been enacted.

Rates at which these taxes are levied, then, are based on amount of capital investment, volume and type of coal mined, or net income from operations. From partial figures on coal company operations, it appears that all taxes paid to county and state are currently averaging about 18 cents per ton mined. The three companies on the tax rolls for the calendar year 1971 paid to the state and local governments 1 1/4 million dollars on 7 million tons mined.

If net tax returns were to be the basis for deciding which is the "best" use for Montana coal, the costs to state and local governments attributable to coal mining and use would have to be subtracted from these tax returns to make a determination. It would be useful to be able to attempt this kind of determination; but until more is known about how much population increase will result, and where, and whether additions to existing towns will accommodate the increase or whether new communities will have to be planned, there is no realistic basis for making the calculations. To the direct tax returns from coal would have to be added taxes and other fees paid by employees of coal mining and utilization industries. For power generation-plus-mining operations, for example, payrolls are reported to average about $10,000 per employee, with this income subject to state income taxes as well as to local property and special taxes, gasoline taxes, and licenses and fees.

"Value added by manufacture" is a rough measure of the relative tax-yielding character of an industry. The added value, however, may be due to high capital investment in machinery and equipment, subject to property taxes; or to high investment in personnel and payrolls, subject to income and other taxes. It cannot be assumed, of course, that increased tax revenues will lead inevitably to lower taxes per capita. Rosebud County, however, has already felt a sharp increase in tax revenues per capita as a result of coal-based operations, without any increase in tax rates for individuals.

4. Employment

Jobs and population increases from coal development will depend on the number and kinds of enterprises that are established, as well as the scale and efficiency of operations. There is considerable variation between employment estimates, as shown in the table below, but it is notable that the lowest figures come from companies actually planning for power and gasification plants.

Process	Scale of Output	Employment	Jobs/1,000,000 tons of coal used
Strip Mining	1,000,000 Tons/yr.	10-20	(depending on scale and efficiency of operation)
Steam-electric Generation	1 unit: 350 Megawatts	44 1/	
	" " "	74 2/	
	2 units: 700 MW total	63 1/	31
	" " " "	91 2/	
	1 unit: 1000 MW	85 2/	
	2 units: 1000 MW total	80 2/	
	4 units: 1000 MW total	110 2/	
Gasification (Lurgi process)	1st unit: 250 MM cu ft/day	500 3/	72
	" " " "	600 5/	80
	" " " "	800-1500 4/	
	Ea. additional unit	400 3/	57

1/ "Summary Data of Colstrip Plant," Montana Power Co. and Puget Sound Power and Light Co., Sept. 1972.

2/ "The 1970 National Power Survey," Federal Power Commission, Dec. 1971, p.I-5-5 (chart).

3/ "Minutes of Meeting with Northern Natural Gas Co. Representative," Montana Dept. of Planning and Economic Development, April 6, 1972.

4/ Parsons, L.F., and D.L. Rubenthaler: "Development in Eastern Montana," (Paper compiled for internal use by Bureau of Reclamation), Great Falls, 1972.

5/ Colorado Interstate Gas Co., (verbal communication), 1972.

There are also wide differences in estimates of total employment and population changes resulting from coal development. U.S. Bureau of Reclamation Director Harold Aldrich of Billings, in a 1968 speech, projected an increase in population of "two and one-half times in the next 50 years" for the "Missouri Basin of Montana." The next year, at a Coal Symposium in Billings, George Darrow, now chairman of the Environmental Quality

Council, spoke of "an industrial complex" combining electric generation and hydrocarbon fuels plants, developing "over a period of years which would support, say, 350,000 people, or a 50 percent increase in Montana's present population."

Even larger numbers are found in a 1972 paper, with unofficial estimates compiled by authors Parsons and Rubenthaler for internal use by the Bureau of Reclamation in Great Falls. Starting with available water supplies, they constructed a hypothetical table of types of coal-based facilities, employees, and resultant population. If all the available water is dedicated to the most labor-intensive type of facility (coal liquefaction), the 43 hypothetical plants result, according to the authors' assumptions, in a population increase ranging from 645,000 to 860,000.

A later "Appraisal Report on Montana-Wyoming Aqueducts" by the same Bureau concludes that, "The ultimate operational phase could easily provide continued employment for 100,000 or more persons. . . .Total population increase could easily exceed one-half million people if the full development potential is realized."

In contrast to these projections, an estimate of employment can be made based on Montana Power Company's employment plans for the Colstrip plant now under construction. If all 53,000 MW of power projected by the North Central Power Study were generated in Montana alone, the number of basic jobs in mining and power generation added to the eastern Montana economy would be around 9,000. If, on the other hand, the same amount of coal used annually to generate this power were utilized instead for coal gasification, the direct employment would rise by about 18,800. At the time of this report (late 1972), unemployment in Montana is at a little over 23,000.

5. Multipliers

The relationship between numbers of jobs and the probable general population is calculated by using "multipliers." One of these describes the numbers of service and professional occupations ("derivative" jobs) that appear in an economy as a result of a given number of new primary or basic jobs. In Montana, this relationship was derived in the Montana Economic Study by the University of Montana's Bureau of Business and Economic Research in 1970, on the basis of statewide historical figures up to 1969, and the multiplier was 2.7. This meant that in general 1.7 derivative employment positions have developed for every basic job, which is defined as a job based on products or services for export and therefore creating income to the community or state from "outside." The multiplier was not worked out for different portions of the state, however, and a study of recently acquired figures giving data by counties indicates that this multiplier is probably lower in the eastern counties, many of which have been characterized by population decrease and economic decline for decades.

Another multiplier is the average size of family or household -- or more accurately, the number of persons supported by each of the income-producing jobs. Use of the average household size (3.1 persons in 1970) to estimate population would give an inflated projection, because it is assumed that each of the jobs would be filled by a separate breadwinner representing a different household. The statewide ratio of population to jobs in 1970 was about 2.8, but this ratio obscures the "true" relationship because it includes a sizable unemployment figure, which would not be characteristic of an area with expanding job opportunities and increasing employment.

Social Impacts

All of the physical changes brought about by use of the coal now lying underground will have some impact, however slight or profound, on people and their society. Changes in employment, land ownership, income and land use will probably have the greatest social impact in general; for individual families a change in their "way of life" will undoubtedly be the greatest impact. A measure of how widespread this might be in the aggregate is suggested by the numbers of people actually living on the land potentially subject to strip mining.

Much of the 800,000 acres is administered by state and federal government. If this is typical of the rest of the land in eastern Montana, then nearly 85 percent is in cropland, pasture, or range. Until a tabulation by smaller census "enumeration districts" can be made, a very rough estimation can be substituted which is higher than the actual figure of those living on coal lands, by adding the populations of the larger county census "divisions." For the 7 counties containing all the subbituminous deposits, now being mined, this gives a total of some 15,000 living on the strip-mineable areas in 1970 and represents about 43 percent of the total population in these counties.

If indeed 800,000 acres, or 1,250 square miles, are disturbed either temporarily (as present state regulations require) or permanently (as some people fear), this amounts to almost a third of the total land area in the 14 counties. How much social impact this would involve depends greatly on the time over which such changes take place. Let us assume that all the power plants reportedly proposed or underway by Montana Power and Puget Power and Light are completed, that an additional 5,000 MW generating capacity materializes, that the coal gasification plants proposed are in operation, and that presently operating coal mining companies build up to their planned production. If this volume of coal consumption were to continue until Montana surface-mineable coal supplies were exhausted, except those on Indian reservations, we would be dealing with a period of 175 years.

Population increase would be inevitable if coal mining and/or utilization are developed intensively, and increased numbers of jobs and people mean social impacts of various kinds. But it must be remembered that the eastern counties have already been undergoing considerable social impact from population and employment changes during the past decades. Although not all the counties have been decreasing in total numbers of people, all but one suffered net out-migration during the past decade. All but one are subject to an "employment gap" amounting to between 6 and 29 percent of total 1970 employment, and averaging 15 percent for the 14 counties. This employment-gap calculation was used in the Montana Economic Study to describe the amount of additional employment growth that would have been required to prevent out-migration of the labor force. It assumes that stopping net out-migration would have required a growth in employment sufficient to absorb the entire "natural" growth of the labor force (which depends on normal population growth rates in the area) and, in addition, reduce the unemployment rate to the 1960 national average. This was 5.1 percent and has been both higher and lower in the interim. By this kind of calculation the "employment-gap" still to be filled in 1970 for the 10-year period amounted to at least 4,400 jobs in the 14 counties, and probably more.

Other kinds of social impacts that can be predicted, but are hard to measure, are the temporary expansion of population in parts of the area because of comparatively large work forces during construction phases of power or other plants, to be followed by contraction to "permanent" operating-personnel populations. Social changes would be involved in reversing downward population trends for some towns, in increases to new highs for others, and in the possible creation of new communities where none existed before. Local governments may have to devise new ways of acting and interacting to make plans and exert controls they decide are needed; and, if changes come too fast, there are potentials for conflicts between communities, between levels of government, and between ethnic groups, economic groups, and others. The population of the eastern counties was about 100,000 in 1970. The addition of half again this number to the population, if it were to occur within the next two census periods, has obvious implications for social and political changes.

Alternatives to Conventional Coal-Generated Power

Most discussions of ways to avoid recognized or suspected ill effects of coal development eventually involve speculation on making the problems go away or at least decrease, either by reducing consumption of power and/or by substituting another source of energy. There are other sources, just as there are alternative methods of getting energy from coal, and each presents its own set of advantages and disadvantages. Important to each method's ability to answer present and predicted demands is the probable timetable of actual availability. The table below presents some of these characteristics in brief outline, with their advantages and shortcomings as compared to generation of power by steam turbines fired by coal, and availability of the technology.

	Advantages	Disadvantages	Predicted Availability
Nuclear Fission	Low pollution	Limited fuel supply, U_{235} Lower efficiency; more waste heat	Current
Fast Breeder Reactor	Creates own fuel supply	Very long-lived radioactive wastes Creates Plutonium	1980+
Nuclear Fusion	Long-term fuel supply No radioactive wastes No danger of runaway reaction	Little increase in efficiency May depend on Lithium supply Needs cryogenic-cooled magnets or very high-energy lasers	2000+
Solar Power by 1. direct conversion by solar cells, 2. optical films that convert energy to steam, or 3. space-born system	"Unlimited" supply	Intermittent supply Large arrays need very large land requirements Efficiency limited by steam engines in case of 2.	1990+
MHD - Direct conversion, gas plasma to current.	Higher efficiency - to 60% Lower emissions Less metal machinery	Extreme high temperatures hard to contain Recovery of expensive ionizing chemicals difficult	1980+
Fuel Cell - direct conversion, gas to electric current	Little pollution Gas lines substitute for overhead power lines No high temperatures Higher efficiencies	Requires supply of natural gas, or other source of Hydrogen	Experimental
Windmills	No fuel costs No by-products	Intermittent supply; usable as supplement only High capital costs Large structures or large land areas required.	Still exploratory
Geothermal Heat	Large energy source	Prime deposits limited Efficiency low; high waste heat	Still exploratory

HIGHWAYS

Introduction

Mining and associated activites in sparsely settled areas attract people and vehicles. These in turn usually create a desire and/or need for more and better highways and roads.

Discussion

If the development occurs near or along an established primary or interstate route, reasonable access to and from the area should not be a major problem. However, if the development occurs in a sparsely settled area served only by relatively low standard secondary highways or county roads, then the pressure for more and better roads becomes a major concern.

Most developers of commercial or industrial properties are reluctant to finance roads to provide access to the areas in which they are involved. Normally, if no other source of funding can be found for a road vital to their operation will they seriously consider providing the necessary financing.

Secondary highway routes and priorities for construction projects on them are established by the county commissioners. Naturally, pressures will come to bear, and secondary highway projects may be provided to give improved access to areas experiencing coal development. This will probably be at the expense of a more rural portion of the county.

Mining and associated activities tend to attract railroad spurs. Railroads and roads in the same area lead to problems if not mutually planned. Serious hazards exist at most, if not all, at grade highway-railroad crossings.

Proper planning for large mines and/or generating plants should include consideration of common transportation corridors to accommodate such facilities as highways, railroads, pipelines, and overhead transmission lines.

To discuss the highway related problems which could result from coal development is most difficult without a knowledge of the magnitude of the development which might occur and all secondary effects of said development. For instance, if the development were to draw some 10,000 new people to be dispersed over several counties, the highway problems could be relatively insignificant. However, if the development were to draw 1,000,000 new people, concentrating them in one area, the number and magnitude of the transportation problems that would arise are difficult to comprehend. Perhaps some sort of mass transit would be appropriate for a large development.

Also, the rate of development would be significant. The impact of well planned and controlled growth spread over many years would be less serious than very rapid growth. Instant cities would expect instant highways. From many standpoints, such as financial and environmental, instant highways are just not feasible. Development of a highway project from conception to contract letting takes from three to eight years, depending upon the magnitude and complexity of the project.

The stability of the development also effects highway planning. A highway system needed for a permanent city would be far different from that for a transitory community.

Before intelligent recommendations can be made about desirable legislation relating to highway problems, there must be some indication of the magnitude of the total development. It could very easily be that the existing laws and highway organization can accommodate all highway problems that might arise. On the other hand, a very large development could require a complete overhaul of laws relating to the financing, constructing, and maintaining of highways, together with a complete reorganization or vast expansion of the Department of Highways.

LAND USE PLANNING

Local Government Role

Montana law places primary authority for land use planning and regulation with local government. It is important to note that the authority of local government to carry out land use planning is tied to a comprehensive process, whereby the projected social, economic and physical future of the planning area is shaped by the goals and objectives of the community and expressed in various interdependent plan elements, such as schools, social services, transportation, open spaces and recreation areas. The local land use plan is one such element of a community's comprehensive plan and it is intended to reflect the goals of the community under an acceptable balance between protection and conservation of physical and natural resources while encouraging and assisting rational use and development necessary to providing economic and social opportunities and other amenities of life for present and future citizens.

City-County Planning Boards

The first significant legislation authorizing cities and counties to form city and city-county planning boards was enacted in 1957. Under this legislation and later amendments, 38 city-county planning boards are now active in Montana and for the most part have prepared comprehensive plans for their jurisdictional areas within cities and for a limited area of normally four and a half miles outside their boundaries. Eight of these boards are now active in the eastern Montana cities of the coal area. Local comprehensive plans have been prepared by Miles City, Glendive, Sidney, Baker, Hardin and Glasgow and preparation of plans is now underway in Forsyth and Wolf Point.

County Planning Boards

The 1971 Legislative Assembly enacted legislation authorizing counties to form county planning boards. As a result of this legislation, considerable flexibility was provided to local governments to perform comprehensive planning on a county-wide basis through either a county planning board encompassing all cities and towns or through a combination of city-county and county boards.

Since July 1, 1972, the effective date of this new law, nearly 30 percent of Montana's counties have established boards or have taken steps to do so (eleven have been formed and five are in process). Only one, Musselshell County, is in the eastern Montana coal area. Rosebud County, after initiating steps to create a county board, later abandoned the effort, apparently because of opposition and a general lack of support from the residents. Despite being at the center of coal development activity, the commissioners chose to create a city-county planning board for only Forsyth and the surrounding jurisdictional area.

Indian Reservations and Private Efforts

Other land use planning activities known to be underway in eastern Montana include comprehensive planning programs within the respective jurisdictional areas of the Northern Cheyenne and Crow Indian Reservations. The Tribal Council of the Fort Peck Indian Reservation is also reported to be negotiating for a federal planning grant, but it is not known whether it is intended to be used for land planning purposes. Western Energy Company has engaged a private planning firm to prepare a comprehensive plan for a "planned community" of approximately 1,800 population on its properties at Colstrip in Rosebud County.

Importance of Financial Aid

All of the local planning activity described above is permissive and is therefore dependent upon concern, initiative and follow-through at the local level. The state has no power to require local units of government to conduct land use planning programs; it does, however, provide professional advice and technical assistance, and administers federal grants for planning. Thus, the Department of Intergovernmental Relations has been able to assist in securing one or more federal planning grants for 28 existing city-county planning boards. Similarly, four out of the eleven newly formed county boards are recipients of grants to assist their initial efforts, and applications from several others are pending the availability of additional funds.

Experience has thus indicated that availability of financial assistance provides a significant incentive and stimulus to local government to undertake and carry out land use planning programs. Because of this, and since federal funds, though larger than in previous years, are inadequate to meet all current needs and pressures, Montana might do well, like many other states, to provide State funds to match federal and local funds for comprehensive planning purposes. Such practice would be especially helpful in small, sparsely populated jurisdictions in eastern Montana where environmental concerns are great, where large scale developments are likely to occur and where the allowed millage levy for planning is often inadequate for effective land use planning and regulation. This financial aspect must also be taken into account in any other measures that may be proposed to overcome weaknesses and to otherwise strengthen the process and application of planning in Montana.

Areas of State Concern

Planning activity in the State's larger cities and towns, and a reasonably good response to county planning in the short time that the authority has existed, would be indicative of progress. Recognition should be made, however, of the fact that actual implementation of planning concepts and regulatory measures has been decidedly slow because of institutional inertia, resistance to change and a basic fear and distrust of planning controls and regulations as interferences with personal values and property rights. The consequence, too often, is that planning becomes more a corrective or remedial activity rather than a preventive and anticipatory process for decision making; instead, adverse consequences should and can be prevented if alternative causes of action are analyzed prior to making irrevocable commitments.

Assurances of citizen participation, clearly stated rights of appeal and adjudication, sanctions with respect to state and federal grants-in-aid, and pre-emtion of authority by a higher level of government under special circumstances are among the major ways in which planning can be made more timely and effective. All of these measures except the last now have application to some degree under Montana law or practice. It is therefore suggested that, in view of impending impacts in eastern Motnana coal areas and elsewhere in the State, consideration be given to empowering an agency of te State of Montana to require implementation of land use planning and regulation when local governments fail to do so in a reasonable time period in areas of critical environmental concern or when large scale developments are imminent.

Subdivision Regulation

Much of what has been said above regarding the implementation of planning is also true of subdivision regulations. Eastern Montana, like most of the State, has not made much, if any, use of legislation empowering City Councils and County Commissions to adopt and enforce subdivision regulations. In fact, so far as is known, in the entire State only Carbon County has adopted regulations pursuant to legislation that was enacted in the 1971 Legislative Assembly. A number of the larger towns in the State have subdivision regulations, and in a few instances County Commissions have arranged for subdivision review by City-County Planning Boards.

Because of this situation and in light of an increasing intensity in subdivision activity (including a probable step-up in eastern Montana), the legislature should be urged to amend and improve existing legislation. Primary consideration should be given to strengthening the present requirement for subdivision regulations by setting a time limit for conformance.

Role of State and Federal Agencies

Local governments have neither the financial resources nor the range and diversity of professional and technical skills necessary for the level of sophistication and depth required in fully comprehensive land use planning. Oftentimes, too, particularly in special resource areas, drainage basins and air sheds, the relationships and interdependencies transcend the jurisdictions of local governments. For these and other similar reasons, the role of both state and federal government agencies is becoming increasingly important for regulatory and control purposes, for technical assistance, and for resource data assembly and analysis.

State Regulations and Controls

In the area of state regulation and control, three examples stand out. The State Department of Health and Environmental Sciences has some degree of authority for state level regulation involving land use. In addition to its regulatory powers over air and water quality, the Department also has authority for approving sanitary facilities in subdivisions of parcels of five acres or less. This authority pertains to safe water supplies and sewage disposal. It does not extend to other important aspects of subdivisions concerned with provision of community services and design relationships to natural features.

The Department of Natural Resources and Conservation is authorized to delineate the 50-year floodway along all streams, and, if the local government fails to adopt and enforce regulations of its own. Since the effective date of the Act, no 50-year floodways have been delineated in eastern Montana, or elsewhere in the State.

The Department of State Lands, in administering and enforcing the Mined Land Reclamation Act, described in detail previously, influences land use by approving restored uses of mined land.

Needs for Inventory and Information Coordination

Numerous state and federal agencies have long been involved in a variety of planning and management programs concerned with resource conservation and development, and many achievements of broad economic, social and environmental goals are attributable to these activities. For example, the Montana Department of Fish and Game inventories fish and game patterns and habitat and plans for fishing access and outdoor recreation areas; the Bureau of Mines and Geology conducts studies of geologic formation, oil and mineral reserves and ground water; the Department of Natural Resources conducts studies of surface and ground water, stream flows, irrigability of lands, soil erosion, and floodways. The State Information Systems Bureau of the Department of Intergovernmental Relations is cooperating with federal agencies on computer application and mapping of resource data in a number of areas including Earth Resources Technology Satellite and the Resource and Land Information programs.

Many federal agencies such as the U.S. Forest Service, the Bureau of Land Management and the Bureau of Reclamation likewise have responsibilities for land and its use from both planning and management standpoints. These particular agencies, which historically have been concerned mainly with natural resource management and development, are also becoming more concerned with roads, highways, recreation development, power transmission and water development.

These and numerous other state and federal programs of a planning and resource management nature have done much over the years to bring about better conservation practices and have produced significant economic and social benefits. But as population has grown and society has become more affluent, more pressure on the land and the resources it provides has occurred. The consequent concern about land use and its relationships to water, air and life generally have pointed up inadequacies and deficiencies in our knowledge base and the great extent to which society depends upon its governments for solutions. There is thus a growing recognition of the need for more inter-agency cooperation and coordination along with demands for more technical assistance and service in resource inventories and analysis for general and multi-purpose application.

Yet, much of the information gathered to date by public agencies has been designed for a specific agency purpose and is therefore often not in useable form for comprehensive and integrated land use planning. In many cases data is gathered and presented on too general a basis for decision-making, or is presented as raw data without analysis and interpretation for use by planners. This is particularly true at the local level where there is almost complete reliance upon inventories and information compiled and maintained by state and federal agencies.

Most agencies have priorities designed to meet responsibilities within their own organizations. As a result there is little if any consistency among agencies either as to the types of data most urgently needed or the regions and geographic areas which should receive priority attention.

Some of the coordination needed to overcome these types of deficiencies is coming about voluntarily as well as through legally prescribed processes. Yet what is needed, and is urgently pointed out by potential coal development in eastern Montana, is a much more refined overall system, involving both state and federal agencies, which sets priorities on data needs and geographic areas coupled with the establishment of specific responsibilities and time schedules for performance.

National Land Use Policy

The proposals for a national land use policy give emphasis to these needs. Among the key features of legislation currently under consideration are priority attention to areas of critical environmental concern and large scale development, the development of comprehensive resource and land information systems, the blending of planning between the public and private sectors, and technical and financial assistance to the states in initiating and carrying on statewide land use planning.

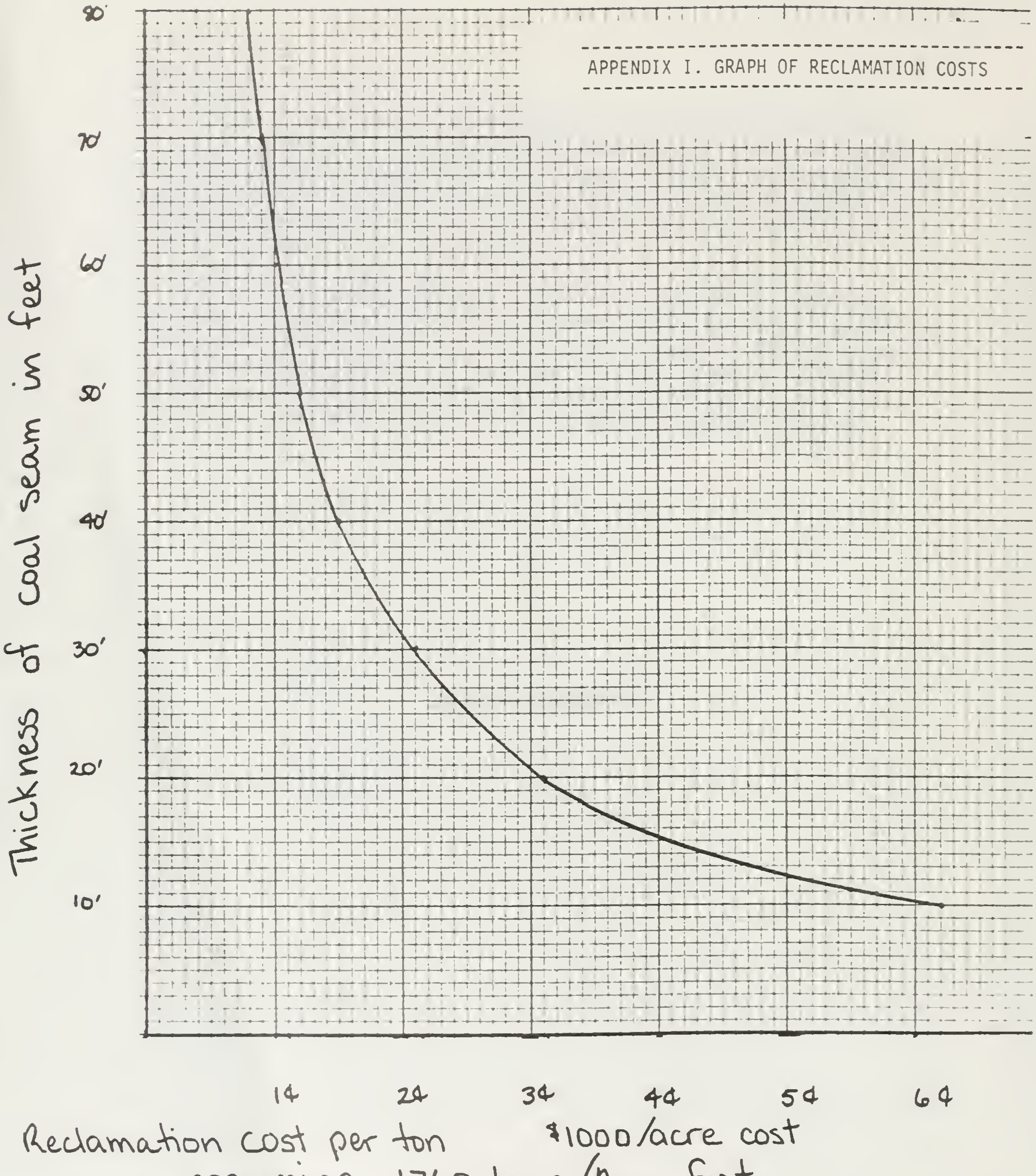
Conclusion

Current trends and forces thus make it clear that the state must and will have a central role in any system of land use planning. Though control and regulation will be a part of that role, emphasis should be upon establishing framework and guidelines for planning which preserves and strengthens the mechanisms and abilities of local levels of government in the processes of self-determination and decision-making.

Effective land use planning on a regional or state level is difficult if basic long-range objectives have not been determined. To answer the question "where does Montana want to go?", fundamental assumptions underlying growth and industrial development must be debated and questioned. Only in this way can we address the real issues concerning the potential changes in land use and life styles associated with coal development in eastern Montana.

APPENDED MATERIAL

APPENDIX I. GRAPH OF RECLAMATION COSTS



$$\text{cost per ton} = \frac{\$1000 \text{ cost/Acre}}{\text{thickness of seam (ft)} \times 1760 \text{ tons/Acre foot}}$$

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ENVIRONMENTAL RESEARCH CENTER
CINCINNATI, OHIO 45268

REPLY TO ATTN OF: Elmore C. Grim **
NDPCA

DATE: November 27, 1972

SUBJECT: Trip Report

TO: Ronald D. Hill, Chief, MDPCA
• John J. Convery, Director
AWTRL

APPENDIX II. EVALUATION OF MONTANA'S RECLAMATION SITUATION
ELMORE C. GRIM, U. S. ENVIRONMENTAL PROTECTION AGENCY

1. Place Visited: Billings, Montana and Vicinity
Sheridan, Wyoming and Vicinity

2. Person Making Trip: Elmore C. Grim

3. Date of Trip: November 12-18, 1972

4. Persons Contacted:

John Goers	Montana Division of Reclamation
John Henson	" " " "
Sharon Solomon	" " " "
Robert Rudio	" " " "
Pat McKelvey	" " " "
Michael R. Grende	" " " "
Jack Ratche	Decker Coal Company
Frank Kinney	" " "
Stu Felde	" " "
R. L. Hodder	Montana State University
Roger C. Rice	Western Energy Company
John Althouse	Westmoreland Resources
Ralph Moore	" "
Bill Chapman	" "
John Andrews	Montana State Government
Gene Tuma	Peabody Coal Company
Leonard Shearer	" " "

5. Purpose of Trip: This trip was in response to a request by Region VIII for technical assistance to the State of Montana on surface mining.

6. Remarks:

An on the ground inspection was made of active and proposed surface mining operations in order to determine if plans that were submitted to the state for approval to strip coal by the various companies, were environmentally sound.

**Elmore Grim is the surface mining specialist for EPA's Mine Drainage Pollution Control Program. He headed Kentucky's mined land reclamation enforcement program for eight years. He visited Montana coal operations during the Environmental Quality Council's tour in September, and returned to assist the Department of State Lands in November.

A. The first area visited was near Roundup, Montana in the Bull Mountains. Being close to Billings, it is a high use area for hunting, fishing and recreation. We saw deer, wild turkey, grouse, pheasant and antelope. This is rimrock country and is very scenic with many natural wind-eroded formations.

Consolidated Coal Company set up a 15 acre experimental coal strip mine using various reclamation techniques such as:

1. Grading - Slopes of varying degrees were left in final grading.
2. Topsoil - Topsoil was saved during mining and used in the experiment. Areas ranged from no topsoil up to an 8" cover.
3. Vegetation - Many combinations of different species were planted.

Comments: Only the topsoiled areas had any vegetation.

Excessive erosion was taking place on all steep slopes. In this type terrain, slopes must be more gentle and precaution taken to control run-off water with contour grading, diversion ditches, and texturing.

This area should not be mined under the present Montana Law as damages to the environment cannot be controlled. Under the very best and most comprehensive laws some areas would have to be deleted.

Mining methods such as pit storage and head-of-hollow fill could be used in certain areas. Most of the mining would be the contour type with some augering. Damages under this type mining could be minimized but not eliminated.

If strip mining is banned in the Bull Mountains, then it should be developed to reach its maximum potential for public use.

Agreements must be made with the landowners to get rid of the "No Trespassing" and "No-Hunting" signs. The public is now being denied use of the land.

Public feeling is against strip mining as evidenced by the "Ban Strip Mining" signs in the area.

B. Western Energy Company, Colstrip, Montana - met with Roger C. Rice, went over the mining and reclamation plans on the site. This company is doing a good job of reclamation. Topsoil is removed and spread on graded areas at least 6" deep.

It was noticed that they are destroying natural, scenic formations by careless mining techniques. They should be required to leave a buffer zone in order to protect these formations. Blasting is also destroying scenic formations in the vicinity by vibrations. We saw damage over 1/4 mile from the operation.

The entire area should be checked for natural, scenic formations and measures taken to protect them for future generations. Protective measures that would help are:

Reduce charges
Shoot fewer holes at one time
Use delay caps
Shoot only during daylight hours

C. Westmoreland Coal Company, Sarpy Creek, Montana - met with Ralph Moore, John Althouse, and Bill Chapman. Went over the mining and reclamation plans. This is a new operation and will not be shipping coal until 1974. Their pre-planning is good and with some adjustments, I think this area can be mined.

Their 1st cut spoil could cause problems if not handled properly. Spoil must be kept out of the numerous deep coulees. It can be placed in selected coulees and be disposed of by "head of hollow fill" method.

Haul roads and ramp roads should be planned so they will not be left open for years, as final reclamation will also be held up. Core samples should be analyzed so as to determine spoil placement.

D. Decker Coal Company, Decker, Montana - met with Jack Ratche, Frank Kinney, and Stu Felde. Went over the mining and reclamation plans.

This company is mining a 52' seam. 1/2 the seam is loaded at one time with trucks always on top of the coal. (Top & Middle).

40 cu. yd. caterpillar scrappers are used in tandem for topsoil removal which is then spread or put in storage.

1st cut spoil could be a problem, since they intend coming back in the future and recovering the coal under it. This spoilpile should not be left in its present condition. It should be graded into the 2nd and 3rd spoil areas and stabilized at not over a 3 to 1 slope. All interior spoils should be graded to a 5 to 1 slope or less.

The U. S. Forest Service from Logan, Utah has fenced in a large graded spoil area and are starting revegetation research projects.

E. Peabody, Big Sky Mine, Colstrip, Montana - met with Gene Tuma and Leonard Shearer. Went over their new proposed mining plan. After some corrections, it should work.

The grading is still not acceptable. Gray slate, shale and clay is being put on top instead of being buried under clean fill and then topsoiled. A self-loading scrapper has been moved on the job and is now removing and spreading topsoil.

A fire has started in one of the exposed coal seams and should be extinguished before it becomes a problem. Care must be taken in handling of exposed coal seams, reject coal and coal in the storage areas and pit, to protect them from fire due to spontaneous combustion. This is a characteristic of lignite and sub-bituminous coal in that precautions must be taken to exclude air or it will catch fire.

Depressions that are holding water should be eliminated as they are becoming saline and create bogs that are death traps for sheep, cattle and game animals. Designed water holding and retarding structures would be acceptable.

Recommendations for strip mining in Montana should include:

1. Reduce all highwalls, perimeters, and roadways to at least a 3 to 1 slope.
2. Grade interior spoils to at least 5 to 1 slope.
3. Control road location, maintenance, bedding down and length of time they may be kept open before final grading.
4. Keep spoil out of all waterways. Waterways are defined as any channels through or along which water runs.
5. Use "head of hollow fill" for excess spoil. Construct fill according to established guidelines.
6. Do not leave any isolated areas of land surrounded by an inaccessible highwall, road or anyother practice that is the result of mining.
7. Leave a buffer zone of undisturbed surface to protect natural, scenic formations.
8. No roads shall be surfaced with coal refuse, reject, or toxic materials.
9. Control dust on roads and around processing areas.
10. Extinguish all fires as soon as they are discovered.
11. Bury all reject coal in the bottom of the pit on the low wall sides cover with clean fill.
12. Bury all the gray colored material that is immediately above the coal and between the seams; in the bottom of the pit, cover with clean fill.
13. Eliminate all depressions that hold water unless approved by the Division of Reclamation.

14. Save all topsoil and spread on final graded areas at least 6" deep. Topsoil is defined as that strata contained in the root zone and will support growth of desirable vegetation. The root zone can be easily recognized by the equipment operator.
15. Core sample analysis should be required. This will help determine spoil placement.
16. Drill all seed. This is the only way to get successful germination. Slope may be a limiting factor in which case, broadcast seeding will be allowed.
17. Irrigate new seeding and plantings if necessary to get them established and maintained. No vegetation effort will be successful if grazing is not controlled.
18. Prospecting could become a problem and should be required to have a permit. Guidelines for prospecting should be established similar to those of surface mining.
19. Blasting practices as now carried out are destroying natural, scenic formations, by vibrations. This could become their number one environmental problem if not controlled immediately.
20. In the interest of economy, efficiency and duplication of efforts, it is mandatory that one agency be designated to correlate all activities on surface mining.

The trip was very beneficial to me as I now feel that I have a better grasp of the problems associated with coal stripping in the Western States.

Ted Schwinden, commissioner, Department of State Lands, is very much aware of the problems associated with surface mining of coal and realized the tremendous expansion that is taking place in Montana. It concerns him in that he does not want Montana to suffer the same fate that has happened to Appalachia.

He has put together the nucleus for a top-notch enforcement agency. In my travels to other states, I have not encountered a more conscientious, dedicated group of personnel. They are few in number but are doing a commendable job under frustrating circumstances.

Montana needs a strict, comprehensive law and adequate funding to support the needs of an expanded enforcement agency.

Elmore C. Grim
Mine Drainage
Pollution Control Activities

cc: Goers Schwinden ✓
Fitch O'Bryon

APPENDIX III. COMPARISON OF PRESENT AND PROPOSED RECLAMATION LEGISLATION

	"THE MONTANA RECLAMATION ACT" (proposed)		"THE MONTANA OPEN CUT OR STRIP MINED LAND RECLAMATION ACT" (effective March 9, 1971)
1.	Selective denial where circumstances warrent.	1.	State may not deny right to mine.
2.	Permit system, permit good for 1 year only.	2.	Reclamation "contract" good until cancelled by mutual consent.
3.	Authority to regulate mining in precipitous terrain.	3.	No control of mining on steep slopes.
4.	Control of entire method of operations.	4.	Control of reclamation plan only.
5.	Maximum bond to insure reclamation is $5,000 per acre.	5.	Maximum bond - $1,000 per acre.
6.	Authority to immediately halt any operation in violation of the law.	6.	Must resort to lengthy legal process to attempt to halt an operation.
7.	Suitable vegetative cover must be established or bond forfeited.	7.	Only two attempts at seeding required.
8.	Statutory authority for contour grading and topsoiling.	8.	Only best reclamation procedures available under the circumstances required.
9.	Violator of law subject to $1,000/day fine, forfeiture of bond, and revocation of permit.	9.	Violator of contract may be sued by state for breach of contract and payment of bond.
10.	Authority to deny permit to repeated violators.	10.	State may not deny right to mine.
11.	Restoration of land must be kept current.	11.	Reclamation to be as current as feasible.
12.	Citizens may act to see that law is enforced.	12.	---
13.	Citizens may recover for damages to ground water supply.	13.	---
14.	A surface owner may recover from an operator for damages from contaminated water draining from the operation.	14.	---